U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
PB80-132673

Management of Small-to-Medium Sized Municipal Wastewater Treatment Plants

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Prepared for

Environmental Protection Agency, Washington, DC Office of Water Program Operations

Jul 79

United States
Environmental Protection
Agency

Office of Water Program
Operations (WH-547)
Washington, DC 20460

June 1979
EPA/430/9-79-013

Water

PB80-132673

EPA

Management of Small-to-Medium Sized Municipal Wastewater Treatment Plants

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO. PB 80 132673
4. TITLE AND SUBTITLE Management from Small to Medium Sized Municipal Wastewater Treatment Plants		5. REPORT DATE EPA/430/9-79-013
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Municipal Construction Division Office of Water Program Division Washington, D.C. 20460		10. PROGRAM ELEMENT NO. 2BG647
		11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Water Program Operations U.S. Environmental Protection Agency Washington, D.C. 20460		13. TYPE OF REPORT AND PERIOD COVERED Technical Report
		14. SPONSORING AGENCY CODE 700/02

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This manual is for the managers of small to medium-sized municipal wastewater treatment plants. Although much of the information would be useful to any plant manager, it is primarily aimed at those individuals managing plants in the range of 3 to 10 mgd.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Water Pollution Control	Management of Waste-Water Plants	

18. DISTRIBUTION STATEMENT Release to the public	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 194
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE PC A09 MF A01

EPA Form 2220-1 (9-73)

MANAGEMENT OF
SMALL-TO-MEDIUM SIZED
MUNICIPAL WASTEWATER TREATMENT PLANTS

by

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July, 1979

Prepared for
U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER PROGRAM OPERATIONS
WASHINGTON, D.C. 20460

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INTRODUCTION

This manual is intended for those who manage wastewater treatment systems. These people, whether they be city managers, mayors, plant managers, or chief operators, play a crucial role in the successful operation and maintenance of the treatment facilities. This success is the key to realizing the full potential of the capital investment associated with the facilities. Regardless of the adequacy of the system design or the skills of the plant staff, plant performance is directly related to the effectiveness of the plant manager. The plant manager must show his staff the style, pace, and attitude he wants them to adopt and maintain.

There are many manuals and handbooks dealing with the technical aspects of wastewater treatment process operations, plant maintenance, troubleshooting, etc. These have been published by the U.S. Environmental Protection Agency, professional organizations, and private concerns. On the other hand, little attention has been given to overall plant management. This manual provides the information needed by plant managers to be more effective in their jobs.

PURPOSE

Although small- to medium-sized municipal wastewater treatment plants constitute over 95 percent of the plants in the United States, the operators of these plants often have limited training or experience in management. Many times their responsibilities encompass a variety of duties, leaving little time for them to develop the skills required to be effective managers. This manual is intended to fill the gaps where the manager lacks experience and to identify areas where he can best develop his management skills.

Completing the simple evaluation form in Section 2 will show the manager areas where his management practices are weak; it also is a handy reference to the sections of the manual which provide specific information on good management practices. Using the guidelines provided in this manual on implementing new or improved management programs will help the manager become more effective and use his time more efficiently.

SCOPE

As indicated by the title, this manual is for the managers of small- to medium-sized municipal wastewater treatment plants. Although much of the information would be useful to any plant manager, it is primarily aimed at those individuals managing plants in the range of 3 to 10 mgd.

Managers of very small plants may not be concerned with all of the topics discussed in the manual. Their staffing structure, for example, might be very simple. They may only have one or two people working for them. On the other hand, their system may be so small that they might operate the plant alone, perhaps on a part-time basis only. In contrast to this, plants greater than 10 mgd serve sizable populations and may involve shift operation and relatively complex staffing and administrative arrangements. In such cases, professionally trained managers may be directing system operations.

The topics addressed in this manual cover the most common areas of deficient management. The information is intended to be comprehensive without being overly specific. Very detailed or localized information was intentionally left out so as not to confuse those managers not affected by it. Examples have been used for illustrative purposes, however, care must be taken to consider how local conditions might influence the actual application of these management tools.

STRUCTURE

This manual is divided into twelve major sections which cover various aspects of plant management. Each section is intended to be self-contained, although there are interrelationships among the topics discussed.

In addition to the table of contents, there is a graphical summary at the beginning of each section of this manual. This illustration identifies the major subject areas discussed in the section and key management tools and practices included in it. This format is useful in quickly identifying the location of a particular subject and showing its relationship to other subjects within the section. The cited references are listed in numerical order at the end of the manual. In many cases, more specific detail on a particular subject is available in these references. A list of the publishers' addresses has been included so copies can be ordered for the plant library.

1 MANAGEMENT OPPORTUNITIES, RESPONSIBILITIES & CONSTRAINTS

OPPORTUNITIES & RESPONSIBILITIES

- Efficient operation to meet legal requirements at reasonable cost
- Adequate record system
- Planning & budgeting
- Good working conditions & employee incentive
- Good public relations

CONSTRAINTS

- Legal framework
- Facility limitations
- Financial
- Staffing
- Public attitude
- Consultants
- Resource availability

SECTION 1

MANAGEMENT OPPORTUNITIES, RESPONSIBILITIES, AND CONSTRAINTS

OPPORTUNITIES AND RESPONSIBILITIES

The proper operation and maintenance of a community's wastewater treatment plant is an important community function. The cost of wastewater treatment can be a big item in the municipal budget. Your responsibility for the wastewater system gives you the opportunity to contribute to a clean, healthful environment at least cost.

It is important that you not only have the technical skills needed but also provide effective management of the system to achieve the primary purpose of the wastewater treatment system - *to provide an adequate level of wastewater treatment in an economical manner*. Your responsibilities to do this include (1):

- Providing efficient, continuous operation of the system so that all legal requirements are met at reasonable cost and without unnecessary consumption of resources
- Maintaining adequate system records
- Providing responsible officials with information essential to planning, budgeting, and management of the system
- Maintaining good working conditions and incentives for employees
- Establishing and maintaining good public relations

Meeting these responsibilities requires teamwork among all involved. It is your job to keep the city management informed of your needs and accomplishments, and how your program fits in with the other city programs. You are the professional from whom other officials expect answers about the treatment plant. As a manager, you must consider the factors of people, finance, and administration as well as the technical aspects of plant operation. As plant size increases, you have to leave more of the technical work to other personnel and concentrate on the management aspects (2). In anticipation of this, you should have an ongoing program to train an assistant who can take over as your responsibilities change.

CONSTRAINTS

Numerous constraints can provide a challenging opportunity for wastewater system managers. These are highlighted here and discussed in more detail in later sections of this manual.

- Federal, state, and local laws and regulations - These include the organizational framework of the utility itself, the level of treatment required by the discharge permit, equal employment opportunity requirements, Occupational Safety Health Act, Federal Clean Water Act and Amendments, local building codes, public utility commission regulations, etc. See Section 4 for discussion.

- Treatment facility - Deficiencies in size, nature or construction may be corrected in time, but can be significant on a short-term basis.

- Financial resources - Legal limits on bonded debts, acceptability of user charges, and compatibility of staff salaries with those in other municipal departments. See Sections 5 and 6 for discussion.

- Staff - Qualifications and number can be modified in time if past problems in employee selection, motivation and training can be overcome. See Sections 7 and 8 for discussion.

- General public - Negative attitudes can result in difficulty passing bond issues or establishing rate increases; good public relations should be established. See Section 9 for discussion.

- Consultants - Various types of consultants can provide invaluable assistance in design, financial planning, operations, and public relations, but can also impose constraints on system management. See Sections 10 and 11 for discussion.

- Resources - Availability and cost of electricity, fuel, chemicals, etc. can be a limitation. See Section 12 for discussion.

2 EVALUATING THE EFFECTIVENESS OF PLANT MANAGEMENT

- Management evaluation form
  - Basic organization
  - Planning & budgeting
  - Staffing
  - Employee relations
  - Public relations
  - Use of consultants

- Problem analysis
  - Define problem
  - Find cause
  - Consider alternative
  - Analyze alternative
  - Adopt solution

SECTION 2

EVALUATING THE EFFECTIVENESS OF PLANT MANAGEMENT

The first step in improving the management of the wastewater treatment system is making an objective, realistic evaluation of current management. Such an evaluation will identify areas in need of improvement. Table 1 is given to assist in the evaluation. Each "No" answer will reflect a target area. The related section(s) of this manual are noted. For example, if the item "The budget has proven realistic" is answered "No," then Section 5 should be used for guidance. Table 1 is not a substitute for a thorough, detailed analysis, but it will point to areas which need more study.

The later sections of this manual provide specific guidance for specific problems. However, the real problem must be correctly and fully defined before they will be useful. For example, high turnover of personnel indicates a problem with employee relations. The problem could be caused by poor salaries, poor working conditions, a supervisor who cannot get along with people, lack of opportunity to advance, or frustration with having more than one boss. The *effect* of "losing too many people" could be related to any one of the above *causes*. Determining the real cause is a key to improved management. A problem cannot be solved until its true cause is known. A decision to make a change to overcome a problem based on the wrong cause will not be effective and may actually worsen the situation.

The following steps provide a logical approach to problem solving which apply regardless of the nature of the problem. Following them will reduce the common errors of jumping to conclusions and adopting the wrong solution.

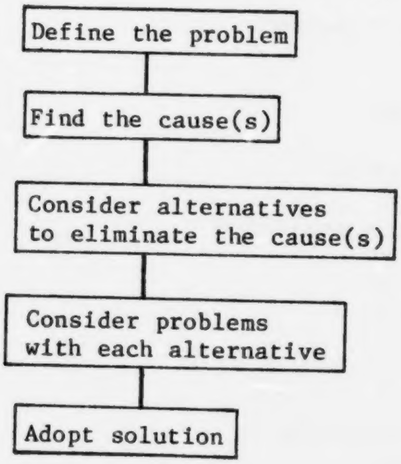

Define the problem
Find the cause(s)
Consider alternatives to eliminate the cause(s)
Consider problems with each alternative
Adopt solution

TABLE 1. MANAGEMENT EVALUATION FORM

Item	Yes	No	If no, refer to manual section
BASIC ORGANIZATION			
Responsibilities assigned based on an organization plan	____	____	3
Each position has a job description	____	____	3
Reporting responsibilities defined	____	____	3
Each individual has only one "boss"	____	____	3
No one supervises more than 5 people	____	____	3
There is an organization manual	____	____	3
PLANNING AND BUDGETING			
An accurate set of as-built drawings is maintained	____	____	5
There is an equipment numbering system for identifying major equipment items	____	____	5
A maintenance schedule is maintained	____	____	5
Cost codes are used to determine where costs are occurring	____	____	5
Accounting records adequately define nature of costs	____	____	5
An annual budget is prepared	____	____	5
The budget has proven realistic	____	____	5
Insurance needs are regularly evaluated	____	____	5
Actual costs are compared to budgets at regular intervals	____	____	5
STAFFING			
Staff size appears to be reasonably balanced with the work load	____	____	7

TABLE 1 (Continued)

Item	Yes	No	If no, refer to manual section
STAFFING (Continued)			
The staff has the skills needed for good plant operation	____	____	7
Operators are encouraged to be certified	____	____	7
Personnel are encouraged to attend training courses	____	____	7
On-the-job training is provided	____	____	7
There has been a lack of accidents and injuries at the plant	____	____	7
Accidents are promptly reported and the causes analyzed	____	____	7
Problems with equipment or treatment processes are quickly corrected	____	____	7
EMPLOYEE RELATIONS			
Turnover of personnel has been reasonable	____	____	8
Employee absenteeism is reasonable	____	____	8
Applicants are interviewed and tested	____	____	8
New employees receive orientation	____	____	8
There is an employee manual which contains policies on vacation, sick leave, etc.	____	____	8
Current employees are carefully considered for promotion to vacancies	____	____	8
Exit interviews are held with employees leaving	____	____	8
Salaries and benefits are competitive	____	____	8

TABLE 1 (Continued)

Item	Yes	No	If no, refer to manual section
EMPLOYEE RELATIONS (Continued)			
Personnel performance measured against established standards	____	____	8
PUBLIC RELATIONS			
Relations with regulatory agencies are positive	____	____	9
Recent bond issues for the wastewater system have passed	____	____	9
Wastewater system personnel frequently attend city council meetings	____	____	9
The relationship with the city council is good	____	____	9
Complaints are promptly handled	____	____	9
Have operators talked to citizens' groups or schools in the last year	____	____	9
An annual public report on plant operations is prepared and distributed	____	____	9
CONSULTANTS			
The plant O&M manual is useful	____	____	10
Procedures based on qualifications and proven experience have been established for the selection of consultants	____	____	10
The need for consulting services is widely advertised	____	____	10
The operators have a good relationship with the consultants	____	____	10, 11
Design consultants follow-up after the plant is in service	____	____	10, 11
Contract clearly defines terms & conditions of technical, financial & legal responsibilities of all parties	____	____	11

3 ORGANIZATIONAL CONSIDERATIONS

TYPE OF OWNERSHIP

- Public
- Private

INTERNAL ORGANIZATION

- Principals of organization
- Structuring an organization
- Job descriptions
  - Example
- Making the organizational plan work
- Relationship with other departments

SECTION 3

ORGANIZATIONAL CONSIDERATIONS

TYPE OF OWNERSHIP

Public

Most of the wastewater treatment systems in the U.S. are publicly-owned. These systems usually operate under one of the following organizations (3):

- The wastewater utility is part of a city department which reports to a city council and mayor (city council form).
- The wastewater utility is part of a city department which reports to a city manager who in turn reports to a city council (city manager form).
- The wastewater utility is separated from other departments and reports to a municipal board or commission other than the city council.
- The wastewater utility is in a separate utility district apart from the city government and reports to a utility board.
- The wastewater utility is a regional authority which serves more than one town or county and reports to an authority board usually made up of representatives from each jurisdiction.

In the small- to medium-sized municipal wastewater treatment systems under the city council form of government, the manager of the wastewater system usually has the chance to be directly involved in decisions made by the city council. The council often turns to the wastewater system manager for status reports and information needed for the city budget.

Under the city manager form, the wastewater treatment system manager is not directly involved with the council. In either form, the wastewater manager's involvement is less if the wastewater utility is part of a larger public works or engineering department. In these cases, the manager's influence on the municipal decision-making process is dependent upon his dealings with the city manager or public works director. The manager's cost analyses and budget preparation can become more complicated if office practices such as accounting and billing are combined with those of other departments or divisions within the same department.

In cases where the wastewater manager reports to a separate municipal board, utility district, or regional wastewater authority, it usually means that the wastewater system activities are separated from other government departments. This often is more efficient because the wastewater manager is in direct contact with his board and is involved in the policy discussions. Separate budgets and accounting also provide for more effective planning.

You should:

- Identify the form of government under which you are operating.
- Concentrate your efforts on providing information and influencing general policy on the right person or persons. Concentrating your communication effort on the wrong person may create poor relations with the people that make management decisions affecting the wastewater system. For example, if you report to a city manager, concentrate your efforts on communicating with him rather than individual council members.

Private

A few cities are served by privately-owned wastewater utilities. These utilities are often operated by corporations whose stockholders elect a board of directors. Each of these utilities usually has a manager who reports to the executive officer of the corporation.

INTERNAL ORGANIZATION

Principles of Organization

There are some widely accepted, basic rules of organization which apply to any size or type of organization (3):

- Each person should have clearly defined responsibilities.
- Each person should always have the authority he needs to meet his responsibilities.
- Each person must know who supervises him.
- The organization should be based on the objectives to be achieved and not on the abilities and limitations of the management or staff.
- No one should have more than one boss.
- No one should directly supervise more than about 5 people (the exact number depends on the nature of the work performed).
- Criticism should be made privately, never in the presence of others.
- Promotions, wage changes, and disciplinary action should be approved by the supervisor directly responsible for an individual.
- The organization should be simple and flexible.

Structuring an Organization

An organization is made up of groups with different functions (such as operations, maintenance, etc.) (4). A planned system is needed to coordinate the efforts of these groups. The structure must establish a clear-cut line of authority and responsibility for each person in the organization. The factors that determine how many people can be supervised include the type of work and the location of the personnel. One construction foreman may be able to supervise 20 laborers working in one small area. However, experts in the management area agree that as a general rule one person should not attempt to directly supervise more than 5 people. The management plan should reflect this consideration.

To illustrate the application of organization principles, consider the organizational framework for a 10 mgd wastewater treatment system. A smaller system may not separate the functions to the same degree but the basic concepts would still apply. The system is an activated sludge treatment plant with the following process:

- Primary Sedimentation
- Aeration Basins
- Aeration Equipment
- Secondary Sedimentation
- Return Activated Sludge Pumping
- Waste Activated Sludge Pumping
- Primary Sludge Pumping
- Chlorine Contact Basins
- Chlorination Equipment
- Gravity Thickening
- Dissolved Air Flotation Thickening
- Vacuum Filtration
- Polymer Feed and Storage
- Incineration

The most important step in setting up the organization is to identify the functions to be carried out. In our example, the wastewater system is separate from other municipal departments. It has its own clerical and accounting staffs. The functional groups which form the organization include:

- Plant operations - The function of the plant is to produce effluent with a required degree of treatment. This is done by the plant staff who operate pumps, valves, and other process controls and equipment.

- Plant maintenance and repairs - The plant equipment, grounds, and structures must be maintained in presentable, safe, and operable condition to be functional. The duties of the maintenance group include equipment repair, preventive maintenance, stocking spare parts and tools, grounds work, etc.

- Collection system maintenance and repairs - Maintenance of gravity sewers may be a fairly simple task done by the plant maintenance crew. Force mains with remote pump stations or combined systems may require a separate maintenance group.

- Laboratory - Specially trained technicians are needed to do laboratory analyses for process control and for compliance with state and federal regulatory requirements.

- Clerical - Clerical tasks required may include cost records, billings, typing letters, maintaining personnel and other files, etc.

Figure 1 illustrates a typical five-function organization. The operation and maintenance functions have been subdivided to reduce the number of subfunctions managed by any one individual. For smaller systems, some functions might be combined and the responsibility of a single individual. There are dangers, however, in assigning too many jobs to one person. All functions must be accomplished regardless of plant size and the one-boss/five-person management policy should not be forgotten. It is important, too, that adequate backup be provided in the event that a staff member is unable to complete his assignments. Don't overlook your own position; have a well-trained assistant who can take over if you're gone.

Job Descriptions

Any organization is made up of people whose functions are different. For example, the operation of the treatment plant and the maintenance of the plant equipment are different functions which are often assigned to different people. The organizational arrangement must offer a means to coordinate the different functions. Each function and the area of responsibility of each individual must be defined.

Misunderstanding and conflict are inevitable if individuals try to define their own duties. Written job descriptions defining the responsibilities of each position will bypass this hazard. Table 2 offers two examples of job descriptions - one for a supervisory position and one for a staff position. As with all job descriptions, they include:

- Position title
- Duties of the position
- Who the individual reports to
- Who the individual supervises
- Qualifications required

Why bother to prepare job descriptions? They actually serve many purposes. They help in recruiting personnel because they present a brief, uniform description of the job to every candidate. They help in screening personnel for transfers and promotions. Appraisals of performance (discussed in Section 8) are more meaningful when they are based on a job description.

If you don't already have job descriptions for some or all positions, here are some suggestions on how to prepare them:

- Ideally, the person in the job should write the first draft himself. If he's never written a job description before, give him some kind of outline to follow or a list of key questions to consider such as:

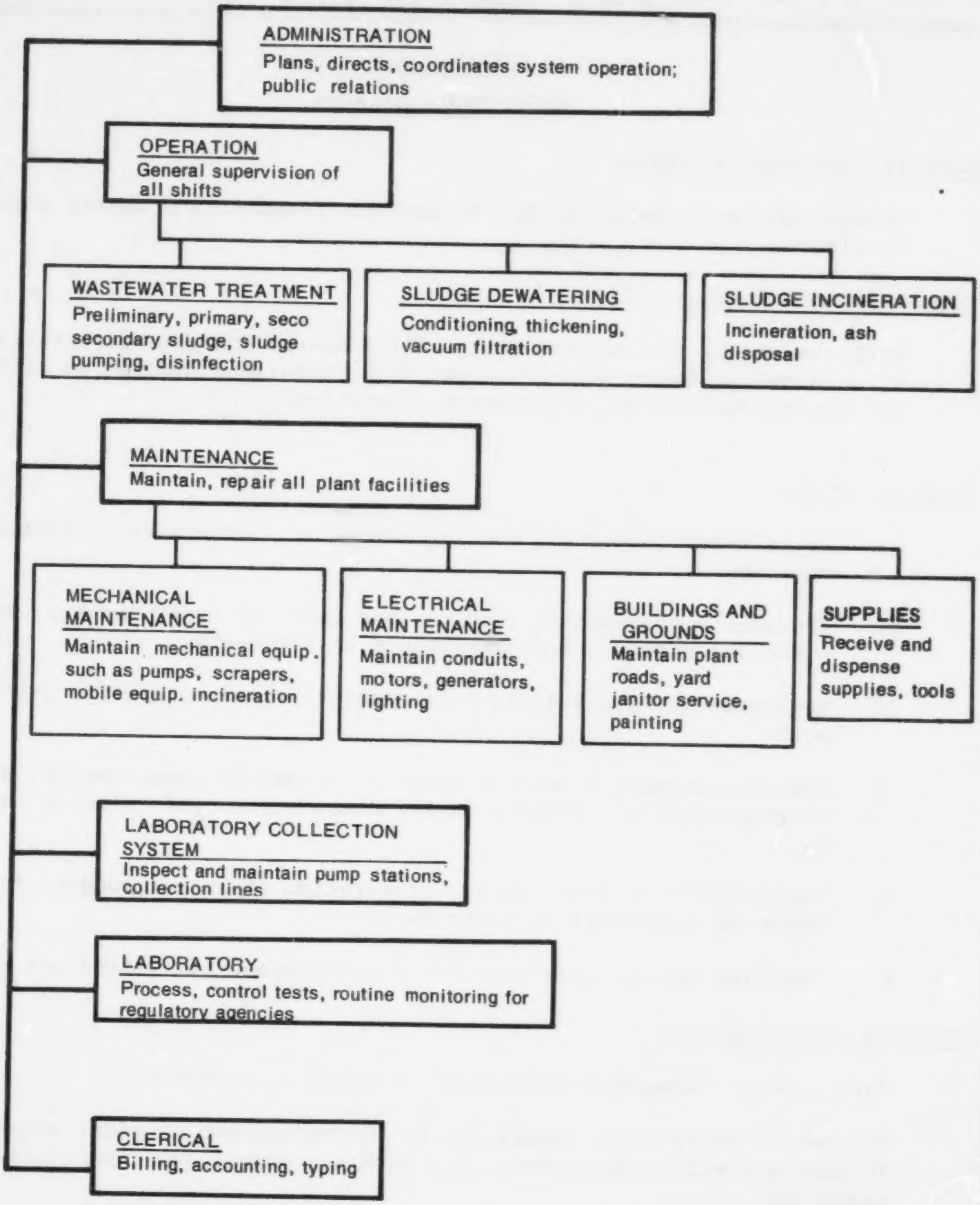

ADMINISTRATION
Plans, directs, coordinates system operation; public relations
OPERATION
General supervision of all shifts
WASTEWATER TREATMENT
Preliminary, primary, seco secondary sludge, sludge pumping, disinfection
SLUDGE DEWATERING
Conditioning, thickening, vacuum filtration
SLUDGE INCINERATION
Incineration, ash disposal
MAINTENANCE
Maintain, repair all plant facilities
MECHANICAL MAINTENANCE
Maintain mechanical equip. such as pumps, scrapers, mobile equip. incineration
ELECTRICAL MAINTENANCE
Maintain conduits, motors, generators, lighting
BUILDINGS AND GROUNDS
Maintain plant roads, yard janitor service, painting
SUPPLIES
Receive and dispense supplies, tools
LABORATORY COLLECTION SYSTEM
Inspect and maintain pump stations, collection lines
LABORATORY
Process, control tests, routine monitoring for regulatory agencies
CLERICAL
Billing, accounting, typing

Figure 1. Organization chart illustrating structure for coordination of different functions.

TABLE 2. EXAMPLE JOB DESCRIPTIONS

EXAMPLE A

MAINTENANCE MANAGER

General Statement of Duties

Manages the maintenance of the wastewater treatment and solids processing facilities.

Organizational Responsibility

Works under the general direction of the System Manager, directs the work of maintenance supervisors. Confers with Operations Manager on critical process operations and maintenance priorities.

Typical Duties

1. Establishes procedures and schedules for maintenance of facilities and equipment.
2. Proposes replacements, repairs, and facility modifications, estimates costs and presents recommendations as necessary.
3. Evaluates results and costs of preventive and corrective maintenance work.
4. Administers maintenance personnel, recommends appointments, assigns responsibilities, directs accident prevention and training activities, etc.
5. Participates in planning and preparation of annual budgets for maintenance of facilities and equipment.
6. Develops and presents reports on maintenance facilities and equipment.

Minimum Qualifications

Three years' management experience in plant maintenance.

Ten years' progressive experience in the management of plant maintenance, including specific experience with both mechanical and electrical equipment.

Desired Knowledge, Skills, Abilities, and Education

Five years' progressive experience in maintenance management of wastewater treatment or other processing industry facilities. Knowledge of equipment, process control, and instrumentation.

TABLE 2 (Continued)

EXAMPLE B

PLANT OPERATOR

General Statement of Duties

Performs skilled work to control physical, chemical, and biological wastewater treatment process.

Organizational Responsibility

Works under the general direction of a Operations Supervisor. Does not supervise other employees.

Typical Duties

1. Monitors the performance of and operates mechanical devices designed to process wastewater.
2. Controls the quantity and quality of solids processed through the use of laboratory test procedures, flow measuring devices, and control instrumentation.
3. Monitors unit process variables and initiates changes as determined through calculations, test procedures, and independent judgement in order to achieve operational goals.
4. Starts up and shuts down components of wastewater treatment processes as required and/or directed.
5. Records quality of treated wastewater using laboratory tests such as turbidity, dissolved oxygen concentration, chlorine residual, colorimetric analyses, and temperature.
6. Samples wastewater and solids processing streams.
7. Provides minor mechanical maintenance, adjustment, and inspection to equipment as directed.
8. Requests maintenance for the repair, modification and/or improvement of equipment as needed.
9. Assists in maintaining equipment and in providing a neat and orderly work area.
10. Keeps unit process operation log sheets.

TABLE 2 (Continued)

Minimum Qualifications

Ability to do problems in decimals and fractions.

Ability to interpret charts and flow diagrams.

Ability to work with minimal supervision and exercise independent judgement.

Ability to perform minor mechanical maintenance.

Ability to understand basic physical, chemical, and biological principles.

Ability to communicate effectively verbally and in writing.

Capable of working with others.

Desired Knowledge, Skills, Abilities and Experience

Licensed wastewater treatment plant operator.

Working knowledge of wastewater treatment plant equipment.

Working knowledge of routine maintenance of wastewater treatment plant equipment.

  - What is your job title?
  - What is the title of the person you report to?
  - Who do you supervise (by job title)?
  - What are your regular duties?
  - How much supervision do you receive? Give some examples.
  - What equipment do you operate?
  - What is your education and experience?

- The supervisor should review the first draft and note any changes he feels should be made. If the person is unable to write his own job description, the supervisor will have to do it.

- The employee and supervisor should sit down together and work out any differences between the first two steps.

Making the Organizational Plan Work

An organizational plan like that shown in Figure 1 provides a structure for coordinating different work functions. However, the plan and related job descriptions cannot provide successful operation of a wastewater treatment system alone. They are only a tool for helping people work together. Good working relationships require understanding and flexibility. Among the key ingredients of a successful organization are:

- Make the organization plan available to everyone.

- All employees should clearly understand the limitations of their functions so that they can do their work right. The manager must thoroughly understand his organization and must watch the areas where overlapping leads to jealousy and friction.

- Be flexible. Modifying the organizational structure should not become a hard or dreaded job.

- Keep people informed. The average human being is curious. He enjoys knowing what's going on, even though it has no direct bearing on his function. The general condition of the city's budget and the activities of other departments are of interest to the people working in the wastewater division. Early release of information on changes in the plant gives people a feeling of being part of the group and reduces "behind the scenes" gossip.

- Encourage employees' groups where the staff can meet to discuss plant problems and plans.

- Be sensitive to people. Be sympathetic to hardship cases, promote from within your staff whenever possible, and maintain conditions which encourage career service.

- Try to anticipate problems so they can be prevented rather than corrected.

- Don't make important decisions when you are tired or emotionally upset.

An organization manual is very useful in letting everyone known where they fit into the system. The manual should include the current organization chart, the job descriptions for each position, and a discussion of how the various groups should work together. Such a manual is also useful in the orientation and training of new employees.

Relationship with Other Departments

Many small- to medium-sized wastewater systems do not include all of the needed functions (such as clerical, accounting, etc.) and rely on other municipal departments for these functions (5). In these cases, coordination and cooperation are extremely important. Even when such services are not involved, you must clearly understand how the various municipal departments work together and how municipal decisions are made (6). Communications with other departments are important because their policies and programs can affect the wastewater system. Day-to-day situations such as closing streets for line repair or replacement call for coordination with the police department and refuse collection operations. Decisions made by the planning or zoning agency can have a major effect on the long-term capacity needs of the system. Budget coordination with other municipal departments is essential if the wastewater system is to be adequately funded. You cannot focus your attention solely on your own organization, but must also communicate and coordinate with other municipal departments (see Section 9).

4 REGULATIONS

- Federal water pollution laws
- State laws & regulations
- Equal opportunity
- O.S.H.A.
- Safe Drinking Water Act
- Industrial pretreatment
- Meeting reporting requirements

SECTION 4

REGULATIONS

The passage of the Federal Water Pollution Control Act (Public Law 92-500) in October, 1972 represented the most complicated and comprehensive regulations related to wastewater treatment ever enacted. It also marked a period in which the number of federal and state laws and regulations affecting the wastewater treatment field increased dramatically. Many of the requirements are directly related to the planning and design of facilities and don't directly impact the management of your system. Only those which most directly affect your management practices will be discussed.

Federal Water Pollution Laws

Public Law 92-500 and the Amendments of 1977 establish several constraints to system management. One of the most direct concerns is the National Pollutant Discharge Elimination System (NPDES) which established a system of discharge permits. The discharge permit for your plant defines the quality of effluent that must be produced, and outlines the tests to be performed, frequency of testing, and acceptable method of sampling to be used with each test. (These are not necessarily the same as your process control tests.) The EPA administers this program except in those states which have been given regulatory authority.

In addition to specifying the effluent quality and sampling techniques, the permit may also establish:

- Pretreatment requirements
- Seasonal requirements for different levels of treatment
- Constraints on sludge disposal
- A schedule for modification of the system
- Monitoring requirements for the receiving stream
- Frequency of reporting

Pretreatment requirements are intended to control the concentrations of certain pollutants in industrial wastewater discharged to municipal systems. These standards apply to heavy metals, trace elements, and other pollutants which are difficult to treat by conventional treatment processes, might upset plant operations, or which could restrict the use of sludges.

Seasonal requirements for different levels of treatment are found in cases where receiving water flows are extremely low at certain times of the year or where fish life may be harmed during summer months and/or periods of migration. For example, ammonia concentrations are sometimes limited to protect fish life during warm weather periods.

Constraints on sludge disposal to protect public health and prevent crop damage may apply if the sludge is used for agricultural purposes or as soil conditioner. Public health related constraints include stabilization requirements for pathogen (disease causing organism) destruction and restrictions on public contact or consumption of food crops. Protection of crops consists of limitations on heavy metals, especially cadmium, which could damage plant life or cause health hazards to consumers of the crop grown.

System modification schedules are usually provided when a new permit is issued having more stringent standards than can be met with existing facilities. These schedules are provided so that your agency has time to build a new facility or modify one that is existing.

Monitoring requirements for the receiving stream are often needed to document the impact of the discharge. Frequency of reporting tells the required time interval for submitting permit reports.

It is essential that you read and understand your discharge permit. If you are uncertain about any of the sections of the permit, contact your state pollution control agency or consulting engineer for clarification. Violations of your permit may result in substantial fines (up to $25,000 per day) imposed on your agency or city. However, if for any reason you don't have the required monitoring data, don't falsify records or reports. Note the causes for the lack of information and leave the records blank. There have been recent instances where operators and local officials have been prosecuted, convicted, and fined for making false reports.

The Clean Water Act Amendments of 1977 also restrict the use of general property taxes and cost recovery from industry for financing wastewater treatment. These restrictions are discussed in Section 6, Financing.

State Laws and Regulations

Most state laws and regulations have been developed to meet federal requirements or modify them to suit local conditions. In addition, many states have a mandatory operator certification regulation and some have voluntary operator certification (see Section 7). Most states define the certification requirements as part of the permit requirement.

Equal Opportunity

Equal employment opportunity is implemented through affirmative action plans. These plans require that no *qualified* individual be refused employment because of race, color, age, or sex and that minority ratios of the surrounding community be somewhat reflected in employment ratios.

You should know your local agency or municipality affirmative action plan. Do not rely solely on a personnel department to tell you who you can or cannot hire. It is important that you have capable, qualified people to operate the treatment plant.

OSHA

The most important development in many years in the field of safety is the Occupational Safety and Health Act (OSHA) of 1970. The purpose of the law is "to assure so far as possible every working man and woman in the nation safe and healthful working conditions and to preserve our human resources."

OSHA provides that each employer:

> Has the general duty to furnish each of his employees employment and places of employment which are free from recognized hazards that are causing or likely to cause death or physical harm; and has the specific duty of complying with safety and health standards promulgated under the act.

The employee has to comply with the safety and health standards and all rules, regulations, and orders issued which apply to his own actions and conduct.

A detailed document, "Occupational Safety and Health Standards," presents very specific standards on mechanical equipment, handrails, chemical handling, emergency equipment, protective clothing and equipment, electrical systems, etc. These standards are available from the U.S. Department of Labor, (Chapter XVII, Part 1910 - Occupational Safety and Health Standards) and contain the following major sections:

- Walking-Working Surfaces
- Means of Egress
- Powered Platforms, Manlifts, and Vehicle Mounted Work Platforms
- Occupational Health and Environmental Control
- Hazardous Materials
- Personal Protective Equipment
- General Environmental Controls
- Medical and First Aid
- Fire Protection
- Compressed Gas and Compressed Air
- Materials Handling and Storage
- Machinery and Machine Guarding
- Hand and Portable Powered Tools and Other Hand-Held Equipment
- Welding, Cutting, and Brazing
- Special Industries
- Electrical

This list reflects the comprehensive nature of these standards. You should obtain a copy of the standards from your city or agency attorney, consulting engineer, or from the regional Department of Labor Office.

Some of the provisions included in OSHA have caused a great deal of concern. The law provides the right of inspectors to come into a plant and investigate the work conditions, to issue citations for violations of standards, and to assess fines against the employer. The law gives employees the right to request an inspection, to accompany the inspector, and to review and have access to certain information.

The law defines specific records that must be maintained by the employer, provides the format for the records, and requires the records be available to the inspector upon request. The law defines standards applicable to many kinds and types of work which are specific and detailed. During an inspection the inspector applies the standards and can fine the employer for violations.

You must do the following to insure compliance with OSHA:

- Review the OSHA standards. Provide equipment and working conditions for employees which meet these standards.
- Provide safety rules to be followed by employees. Also, safety tips, such as lifting techniques to prevent back injury, should be provided.
- Observe employee work habits and remind them that they are also responsible for accident prevention.

Safe Drinking Water Act

This act will normally not directly impact sewage treatment plant management. However, increased restrictions on disposal of water treatment sludges and requirements for higher levels of water treatment may increase the interest in disposing of the water plant sludges to the sewage treatment plant. Collection system maintenance is an important aspect of cross-connection control.

Industrial Pretreatment

The Clean Water Act Amendments of 1977 require that industrial dischargers to municipal systems meet pretreatment standards. These standards have been developed by the EPA. It is the responsibility of the municipality to monitor industrial dischargers to see that pretreatment standards are met. Individuals with special training in industrial waste monitoring should be responsible for the program. Due to the importance of this program, this person should answer directly to the superintendent rather than being part of another group such as the laboratory. If there are only one or two individuals providing all the labor for the system operation, maintenance, and laboratory testing, they should obtain additional training to meet this requirement.

Meeting Reporting Requirements

The above regulations impact management of small- to medium-sized municipal wastewater treatment plants by greatly increasing the administrative requirements or "paperwork." This work takes time and results in increased labor for the superintendent and secretary as well as support staff. A chart should be prepared listing all report and record keeping requirements with due dates for each. You can then make a work plan so you can routinely and efficiently prepare the needed reports.

5 PLANNING, PROGRAMMING & BUDGETING

RECORDS – THE BASIS FOR PLANNING

- Importance of good records
- Types of records
- Performance records
  - –Typical report forms
- Physical facilities
- Maintenance
  - –Sample equipment record card
  - –Sample inventory card
  - –Sample storeroom ticket
  - –Sample purchase order
- Cost records

LONG RANGE PLANNING

O & M budgets
Capital budgets

EMERGENCY PLANNING

Preventative maintenance
Standby power
Operations plan

INSURANCE

- Fire and other damage coverage
- Liability

SECTION 5

PLANNING, PROGRAMMING, AND BUDGETING

RECORDS - THE BASIS FOR PLANNING

Importance of Good Records

Keeping records is important for the long-term operation of the system. Good records should:

- Verify the efficiency of process units and the overall treatment system
- Assist in making decisions affecting plant operation
- Assist in planning and maintaining system equipment
- Maintain separate costs for different functions such as operation, maintenance, laboratory, etc.
- Provide a basis for budgeting and staffing
- Provide a source of reliable information for plant operators, consultants, and regulatory agencies which will survive changes in personnel
- Provide a basis for justifying system expansion or modification

Types of Records

The types of records of importance in the operation, planning, and budgeting of a wastewater system include (7):

- Performance
- Physical facilities
- Maintenance
- Costs

Performance Records

Performance records help in making process control decisions, document conformance with discharge standards, and provide a basis for plannng expansions or modification of the treatment processes. The EPA discharge permit specifies the required effluent quality tests and frequency of tests. In many cases, the state regulatory agency may require more frequent reports than EPA. Additional laboratory analyses are usually required for efficient control of plant operation. The EPA report, "Estimating Laboratory Needs for Municipal Wastewater

Treatment Facilities," EPA-430/9-74-002 (8), contains guidelines on the minimum type and frequency of tests required for the proper control of a wide variety of unit processes. You should order a copy of this report from EPA and check your laboratory program against the report recommendations. The WPCF Manual of Practice No. 11, "Operation of Wastewater Treatment Plants," presents some typical report forms for data from different types of plants and processes. These are reproduced in Figure 2.

You should carefully examine the laboratory records to:

- Insure that all analyses provide information that is actually *needed and used*. Ask yourself, "What do I use this test result for?"

- Insure that your test program is providing the data for needed planning purposes. You can do this by reviewing your testing program with your consulting engineer or other qualified individual.

In addition to analytical records, the plant should keep a daily log of weather conditions, equipment failures, construction activities, accidents, complaints received, and other information about the operation of the system such as units in service, mode of operation, etc. A convenient method for summarizing operational data is in graphical form. Seasonal trends can then be easily identified.

Physical Facilities

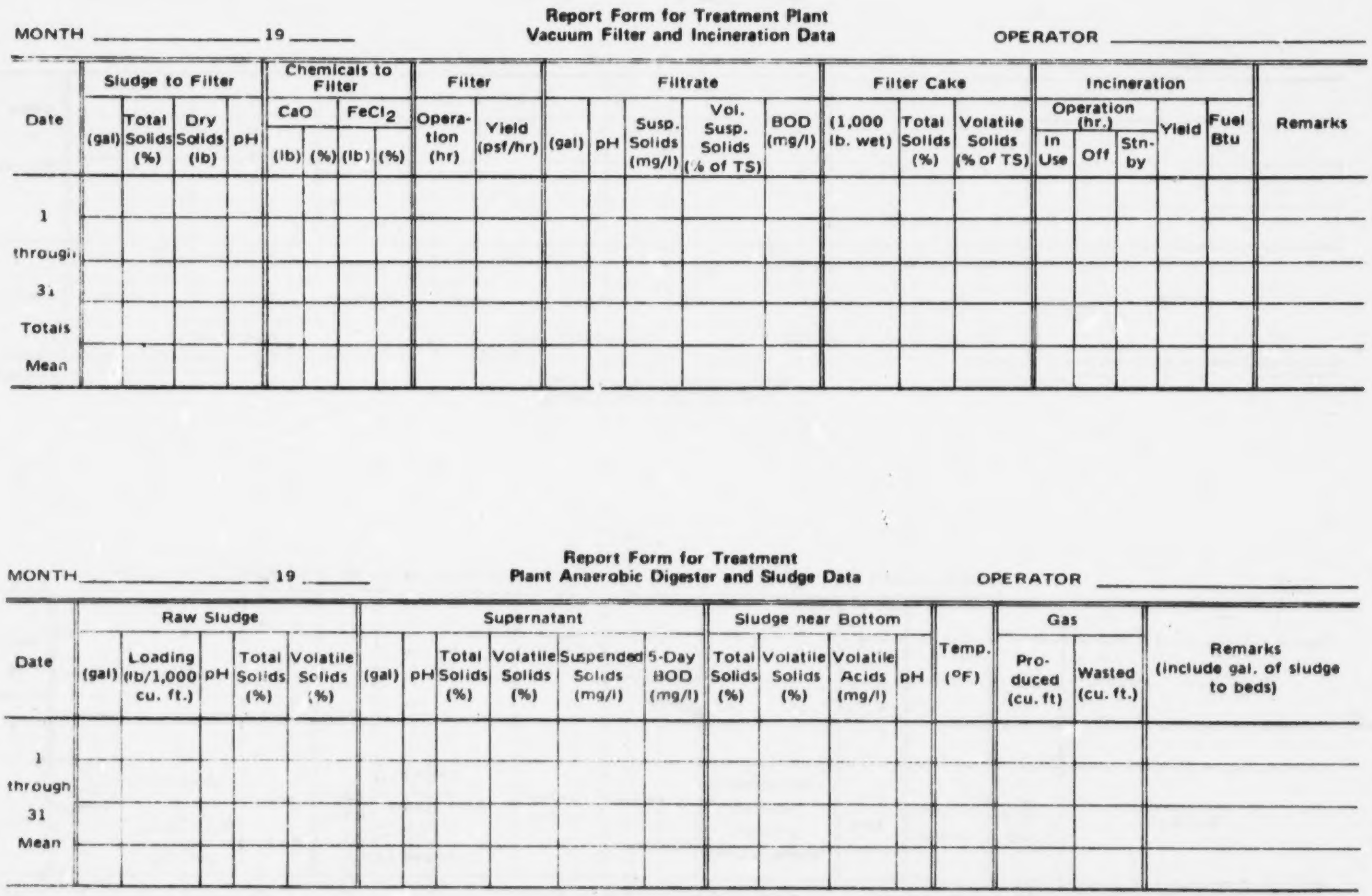
Unfortunately, wastewater system personnel sometimes break a pipeline that is not located as shown on plans or which was added with no records ever made of its location. It is important that an accurate set of as-built drawings and specifications be kept, including any additions or changes made by plant personnel.

Maintenance

Maintenance records are a key part of a sound program. You should study the EPA report "Maintenance Management Systems for Municipal Wastewater Facilities," EPA 430/9-74-004 (9) which contains detailed guidance on establishing good maintenance records. The maintenance records should contain:

- Equipment records - Each item of equipment should be numbered. You should keep a card file on each item (filed numerically) with the following information:

    - Name and location of equipment or structure
    - Name and address of manufacturer, supplier, or builder
    - Cost and installation date
    - Type, style, model
    - Capacity, size rating
    - Serial and code numbers
    - Nature and frequency of maintenance
    - Proper lubricants and coatings



MONTH ________________ 19 ______

Report Form for Treatment Plant
Vacuum Filter and Incineration Data

OPERATOR ________________

Date	Sludge to Filter				Chemicals to Filter				Filter		Filtrate					Filter Cake			Incineration					Remarks
					CaO		FeCl$_2$												Operation (hr.)					
	(gal)	Total Solids (%)	Dry Solids (lb)	pH	(lb)	(%)	(lb)	(%)	Operation (hr)	Yield (psf/hr)	(gal)	pH	Susp. Solids (mg/l)	Vol. Susp. Solids (% of TS)	BOD (mg/l)	(1,000 lb. wet)	Total Solids (%)	Volatile Solids (% of TS)	In Use	Off	Stn-by	Yield	Fuel Btu	
1																								
through																								
31																								
Totals																								
Mean																								

MONTH ________________ 19 ______

Report Form for Treatment
Plant Anaerobic Digester and Sludge Data

OPERATOR ________________

Date	Raw Sludge					Supernatant						Sludge near Bottom				Temp. (°F)	Gas		Remarks (include gal. of sludge to beds)
	(gal)	Loading (lb/1,000 cu. ft.)	pH	Total Solids (%)	Volatile Solids (%)	(gal)	pH	Total Solids (%)	Volatile Solids (%)	Suspended Solids (mg/l)	5-Day BOD (mg/l)	Total Solids (%)	Volatile Solids (%)	Volatile Acids (mg/l)	pH		Produced (cu. ft)	Wasted (cu. ft.)	
1																			
through																			
31																			
Mean																			

Source Reference 7

Figure 2. Typical report forms.

MONTH ________________ 19 ______

Report Form for Treatment Plant Miscellaneous Data

OPERATOR ________________

Date	Weather				Raw Sewage				Grit (cu. ft./ mil gal.)	Screening (cu. ft./ mil gal.)	Plant Effluent, Coliform Density (MPN/100 ml)	Chlo-rine (lb)	Power (kw-hr.)	Aux. Fuel †	Remarks
	Precip. (in.)	Temp. (°F)		Type*	Temp. (°F)	Flow (mgd)		pH							
		(max)	(min)			Avg.	Max.								
1															
through															
31															
Mean															

*C–Clear; W–Windy; CL–Cloudy; CA–Calm; R–Rain; S–Snow.

† Indicate kind and unit of volume.

MONTH ________________ 19 ______

Report Form for Treatment Plant Primary Treatment Data

OPERATOR ________________

Date	5-Day BOD					Suspended Solids					Suspended Volatile Solids				Remarks
	Influent		Effluent		Removal (%)	Influent		Effluent		Removal (%)	Influent		Effluent		
	(mg/l)	(lb)	(mg/l)	(lb)		(mg/l)	(lb)	(mg/l)	(lb)		(mg/l)	(lb)	(mg/l)	(lb)	
1															
through															
31															
Mean															

Source Reference 7

Figure 2. (continued)

VOLUME (cu. ft.) ____________
MONTH ____________ 19 ______

Report Form for Treatment Plant Trickling Filter Data

RECIRCULATION PATTERN ____________
OPERATOR ____________

Date	R*	5-Day BOD					Suspended Solids					Suspended Volatile Solids		Removal		Remarks
		Primary Effluent (lb/day/ 1,000 (cu. ft.)	Final Tank Effluent		Removal		Primary Effluent (lb/day/ 1,000 (cu. ft.)	Final Tank Effluent		Removal		Final Tank Effluent		Total Plant		
			(mg/l)	(lb)	(%)	(lb/day/ 1,000 cu. ft.)		(mg/l)	(lb)	(%)	(lb/day/ 1,000 cu. ft.)	(mg/l)	(lb)	BOD (%)	Suspended Solids(%)	
1																
through																
31																
Mean																

*R = $\frac{\text{Filter Influent}}{\text{Plant Influent}}$

MONTH ____________ 19 ______

Report Form for Treatment Plant Activated Sludge Data

OPERATOR ____________

Date	Air Applied			5-Day BOD			Suspended Solids		Suspended Volatile Solids		Removal		DO Final Effluent (mg/l)	Mixed Liquor				Return Sludge		Waste Sludge (1,000 gal.)	Remarks
				Primary Effluent (lb/day/ 1,000 cu. ft.)	Final Effluent		Final Effluent		Final Effluent		Total Plant										
	(hr)	(cfm)	(cu. ft/lb BOD Rem.)		(mg/l)	(lb)	(mg/l)	(lb)	(mg/l)	(lb)	BOD (%)	SS (%)		Suspended Solids (%)	Settleable Solids 30 min. (%)	Sludge Density Index	DO (mg/l)	(%)	SS (mg/l)		
1																					
through																					
31																					
Mean																					

Source Reference 7

Figure 2. (continued)

MONTH ____________ 19 ______

Report Form for Treatment Plant Intermittent Sand Filter Data

OPERATOR ____________

Date	Dose (gpd/ sq. ft.)	5-Day BOD						Suspended Solids						DO Final Effluent (mg/l)	Remarks
		Influent		Effluent		Removal		Influent		Effluent		Removal			
		(mg/l)	(lb)	(mg/l)	(lb)	Sand Filter (%)	Total Plant (%)	(mg/l)	(lb)	(mg/l)	(lb)	Sand Filter (%)	Total Plant (%)		
1															
through															
31															
Mean															

MONTH ____________ 19 ______

Report Form for Treatment Plant Aerobic Digestion and Sludge Data

OPERATOR ____________

Date	Raw Sludge							Digesting Sludge						Digested Sludge				Supernatant	
	Volume (gal.)	Loading (lb/1,000 cu. ft.)	pH	TS (%)	VS (%)	COD (mg/l)	N (mg/l)	pH	TS (%)	VS (%)	COD (mg/l)	N (mg/l)	DO (mg/l)	pH	TS (%)	VS (%)	N (mg/l)	TS (%)	N (mg/l)
1																			
through																			
31																			
Mean																			

Source Reference 7

Figure 2. (continued)

The same or separate cards should be used to record maintenance work done, the type of the work, and who performed the work. Figure 3 is an example card.

- Records showing schedules for maintenance work - Charts should show maintenance tasks to be carried out daily, weekly, monthly, quarterly, semiannually, and annually.
- Records of inventory - A card system to record information on quantity, item number, description, when last purchased, cost, date, vendor, and other information is helpful. When items are taken from this stock, the date and use should be noted on the card. For items which may have long lead times, a reorder point should be established. Figures 4, 5, and 6 are example forms for control of inventory and ordering of items.
- Costs - As discussed in the next section, accurate maintenance cost records are very useful in budgeting and in planning equipment replacement.

Cost Records

The proper control of the management of the system and budgeting is dependent upon accurate cost records. The cost accounting system should provide a detailed breakdown of past costs so that future expenditures can be planned. You should review the WPCF Manual of Practice No. 10, "Uniform System of Accounts for Wastewater Utilities," for detailed information on cost accounting systems.

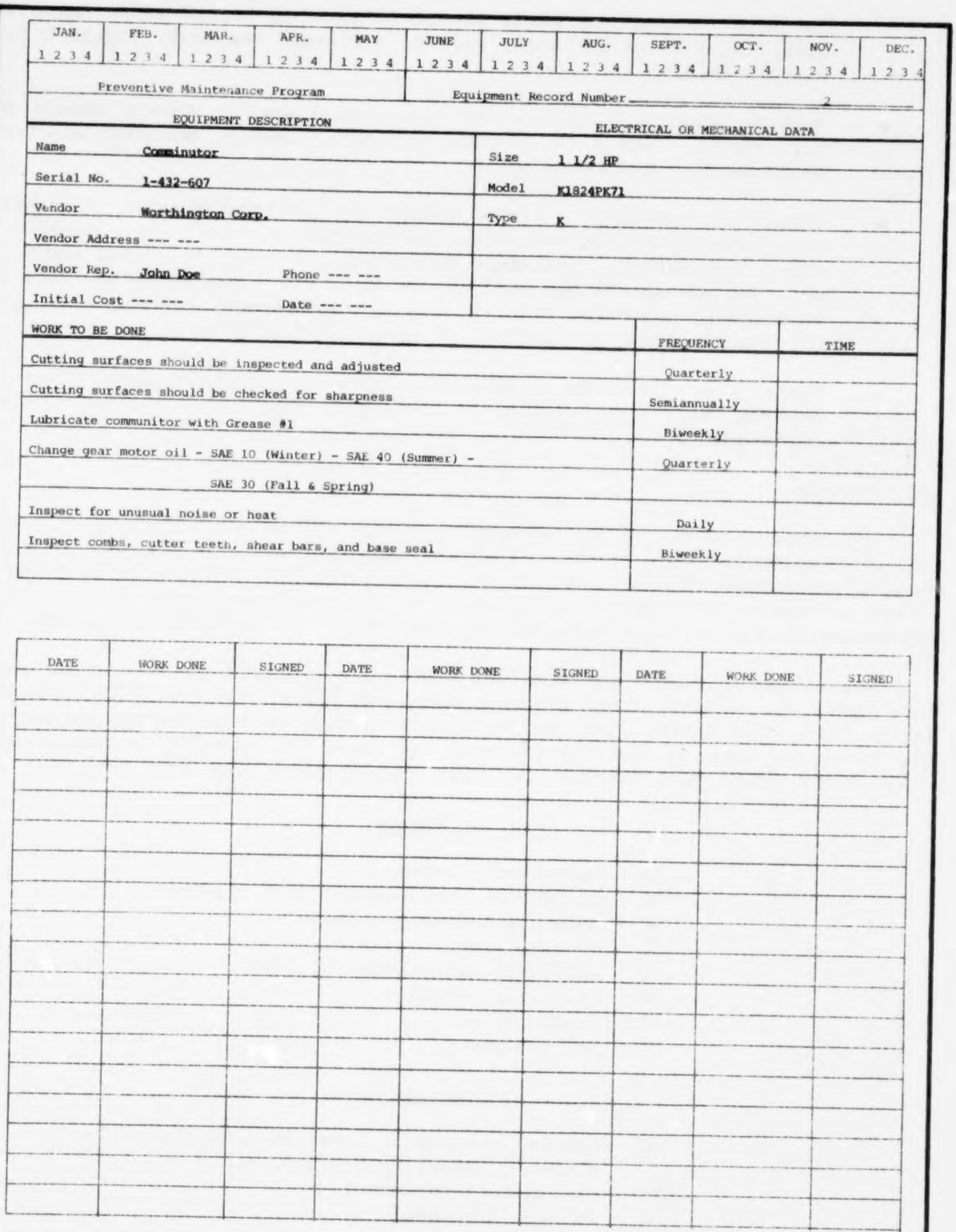
Evaluation of labor and material costs can be based on the proper use of time cards and records which describe what was being done (function) and where it was being done (area). This can be done by having each person use a coded system to report what he was doing during the day. For example, a simple system which would report both function and area charges might look like this (4):

Function Charge

20 - Operations, labor
30 - Operations, maintenance work, labor
40 - Upkeep maintenance, labor
50 - Repair, labor
60 - Additions and expansion, labor
80 - Operating supplies
81 - Repair parts
82 - New equipment

Area Charge

100 - General operations (includes administrative duties, laboratory testing, etc.)
200 - Preliminary treatment
300 - Primary treatment
400 - Secondary treatment



JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4

Preventive Maintenance Program

Equipment Record Number 2

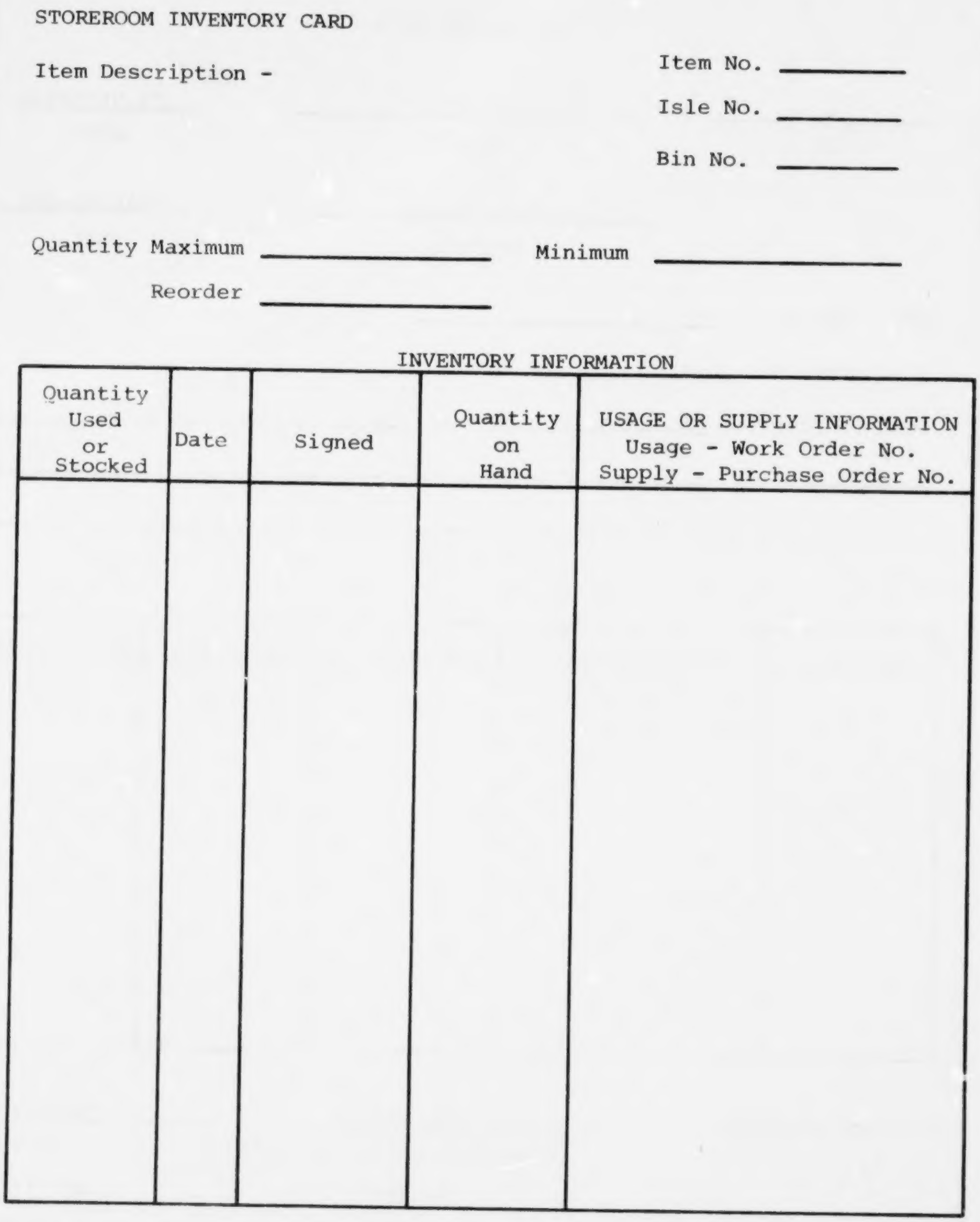
EQUIPMENT DESCRIPTION		ELECTRICAL OR MECHANICAL DATA
Name **Comminutor**		Size **1 1/2 HP**
Serial No. **1-432-607**		Model **K1824PK71**
Vendor **Worthington Corp.**		Type **K**
Vendor Address --- ---		
Vendor Rep. **John Doe**	Phone --- ---	
Initial Cost --- ---	Date --- ---	

WORK TO BE DONE	FREQUENCY	TIME
Cutting surfaces should be inspected and adjusted	Quarterly	
Cutting surfaces should be checked for sharpness	Semiannually	
Lubricate communitor with Grease #1	Biweekly	
Change gear motor oil - SAE 10 (Winter) - SAE 40 (Summer) -	Quarterly	
SAE 30 (Fall & Spring)		
Inspect for unusual noise or heat	Daily	
Inspect combs, cutter teeth, shear bars, and base seal	Biweekly	

DATE	WORK DONE	SIGNED	DATE	WORK DONE	SIGNED	DATE	WORK DONE	SIGNED

Source Reference 9

Figure 3. Sample equipment record card.



STOREROOM INVENTORY CARD

Item Description -

Item No. ________

Isle No. ________

Bin No. ________

Quantity Maximum ____________ Minimum ____________

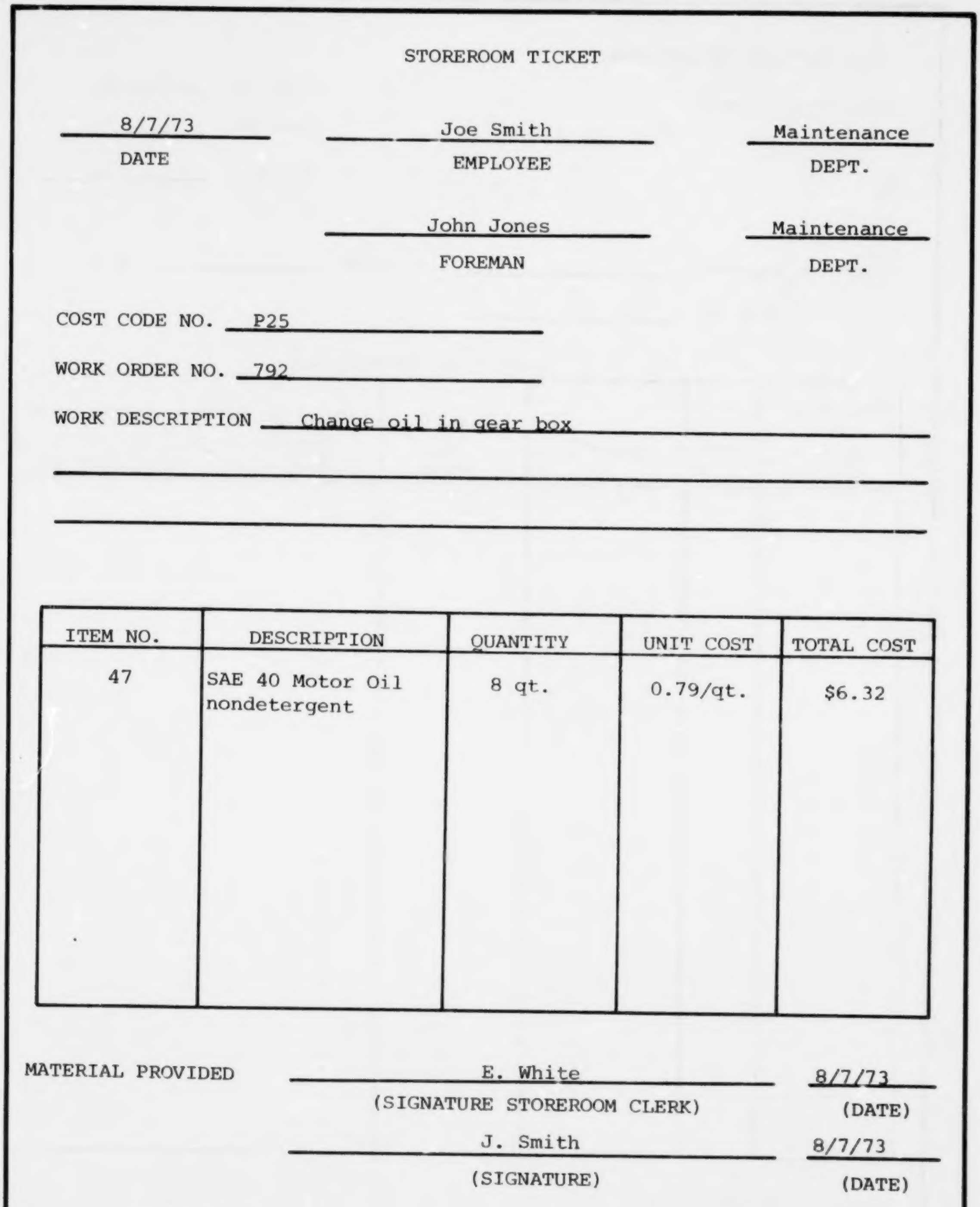
Reorder ____________

INVENTORY INFORMATION

Quantity Used or Stocked	Date	Signed	Quantity on Hand	USAGE OR SUPPLY INFORMATION Usage - Work Order No. Supply - Purchase Order No.

Source: Reference 9

Figure 4. Sample inventory card.



STOREROOM TICKET

8/7/73	Joe Smith	Maintenance
DATE	EMPLOYEE	DEPT.
	John Jones	Maintenance
	FOREMAN	DEPT.

COST CODE NO. P25

WORK ORDER NO. 792

WORK DESCRIPTION Change oil in gear box

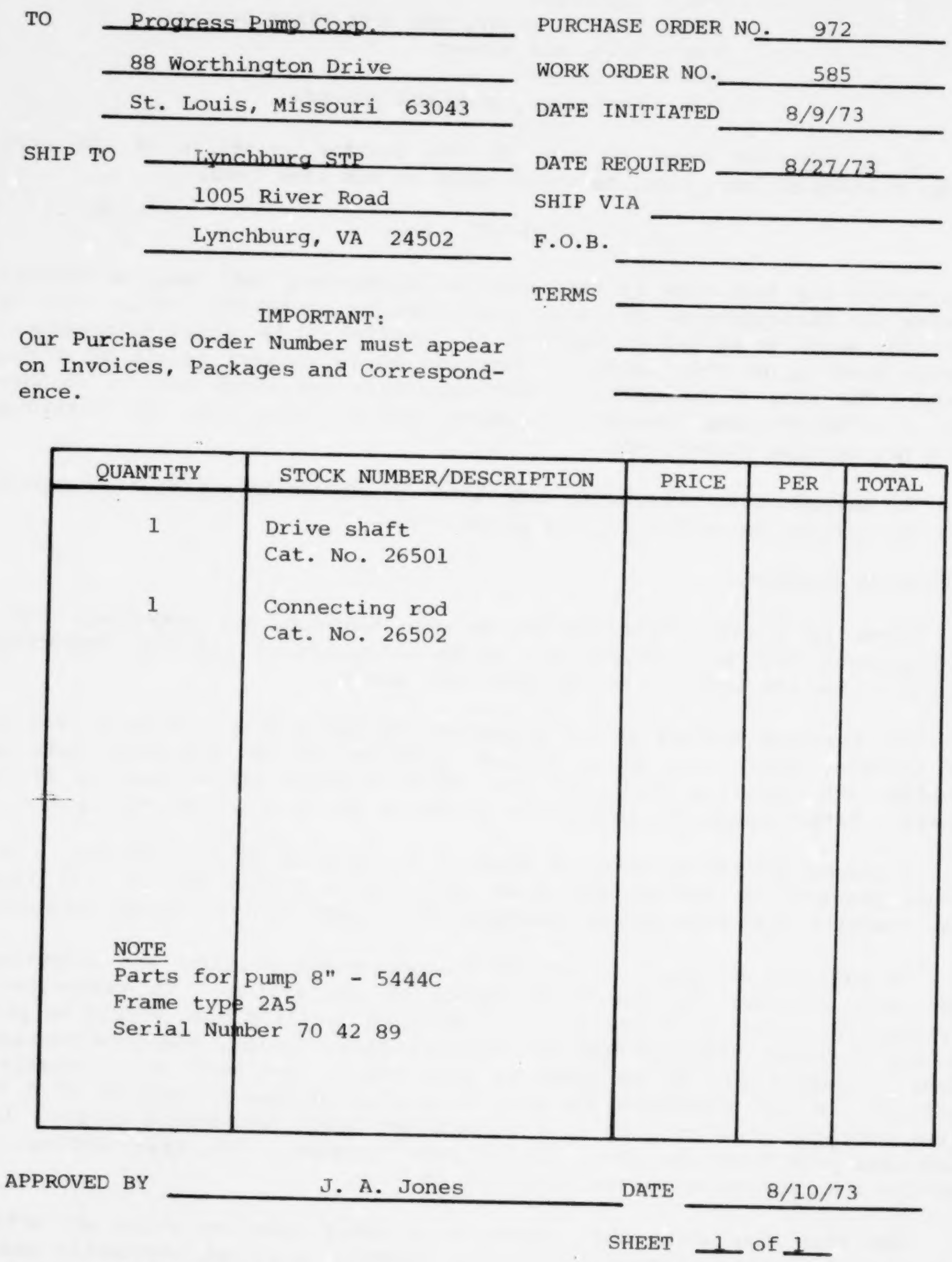
ITEM NO.	DESCRIPTION	QUANTITY	UNIT COST	TOTAL COST
47	SAE 40 Motor Oil nondetergent	8 qt.	0.79/qt.	$6.32

MATERIAL PROVIDED E. White (SIGNATURE STOREROOM CLERK) 8/7/73 (DATE)

J. Smith (SIGNATURE) 8/7/73 (DATE)

Source: Reference 9

Figure 5. Sample storeroom ticket.



TO Progress Pump Corp.
88 Worthington Drive
St. Louis, Missouri 63043

SHIP TO Lynchburg STP
1005 River Road
Lynchburg, VA 24502

PURCHASE ORDER NO. 972
WORK ORDER NO. 585
DATE INITIATED 8/9/73
DATE REQUIRED 8/27/73
SHIP VIA
F.O.B.
TERMS

IMPORTANT:
Our Purchase Order Number must appear on Invoices, Packages and Correspondence.

QUANTITY	STOCK NUMBER/DESCRIPTION	PRICE	PER	TOTAL
1	Drive shaft Cat. No. 26501			
1	Connecting rod Cat. No. 26502			

NOTE
Parts for pump 8" - 5444C
Frame type 2A5
Serial Number 70 42 89

APPROVED BY J. A. Jones DATE 8/10/73

SHEET 1 of 1

Source: Reference 9

Figure 6. Sample purchase order.

500 - Digestion
600 - Filter, drier, and fertilizer storage
700 - Power and blower
800 - Utilities
900 - Warehouse, shop and grounds

If an operator spent an hour in the routine operation of the activated sludge portion of the plant, he would enter on his time card:

20-400 1 hour

An operator may from time to time perform maintenance work such as making minor repairs to chlorinators. All work performed by operators, other than routine operation would be placed in function 30. Function 40 is upkeep maintenance; janitorial work is in this category. Function 50 is repair; repair of a pump for example. Function 60 is additions and expansions for items such as an installation of a better pump seal-water system, general minor new installations, and minor new process piping, etc.

The example cost accounting code shown above can be modified to provide the type of information needed for any given system.

LONG-RANGE PLANNING

There is a close relationship between planning and budgeting. The *planning* process determines the goals to be accomplished and the *budgeting* process provides the tools to accomplish these goals.

The planning process should establish the goals over a 3- to 5-year period. For example, such goals might include cleaning of the digester, painting all building exteriors, or replacing five miles of sewer lines known to be in poor repair. Target dates for completion should be established for each goal.

A common problem is actually finding the time to do the planning. The day-to-day problems of running the plant may seem to occupy all of your time. You must remember that even modest planning efforts will reduce future problems.

In addition to year-to-year and month-to-month planning and budgeting, you must also consider the long-term future of the system. As wastewater flows approach the capacity of the plant, a detailed facility plan should be prepared. Because the time required for the facility plan, design, and construction of a plant expansion can be as long as five years, you need to carefully watch increases in raw wastewater flows. If your plant has a capacity of 1 mgd and flows increase at a rate of five percent per year, you should begin a facility plan when your flows are about 700,000 gpd. Remember, too, that additions to the service area may cause sudden increases in flow.

You must also watch the activities of other agencies which may affect the long-term operation of your system. For example, regional wastewater management plans or "208 plans" may propose that your plant be eventually replaced by a regional facility or that it serve as the site for a regional plant. You should find out which agency is doing the 208 plan in your area and determine the status of its work. Your consulting engineer or state pollution control agency should be able to help you with this. If the 208 plan is still under preparation, you should take the opportunity to contribute to the planning effort.

BUDGET PREPARATION AND CONTROL

The wastewater manager must consider budgets for:

- Operation and maintenance of the existing system
- Capital expenditures for the modification or expansion of the existing system

Operation and Maintenance Budgets

The basic questions in budget preparation are:

- What tasks or jobs have to be accomplished in the next year?
- When should each of these jobs be done?
- How much time, money, and materials will each job require?
- Who should work on these jobs?

The goals of budgeting are to:

- Control expenditures within planned amounts
- See if any unusual costs are occurring
- Have records that may lead to future savings
- Schedule availability of funds

Typically, the budget is first developed by the head of each department. For example, you may ask the maintenance superintendent to prepare the first draft of the maintenance budget for the next year. You can then review each proposed budget and develop a system wide budget. You must balance the needs of the entire system with the available resources. Unless there has been or will be a major change in the system from the previous year, the records of actual costs will provide a good basis for budgeting. The labor from the past year, when coupled with the expected salary rates for the coming year, is a good basis for budgeting labor costs. The following example (9) illustrates the basic steps in preparing a maintenance budget. By studying the maintenance history for the plant and making allowances for equipment replacement and contract maintenance work, a sound maintenance budget can be developed. The same basic approach can be applied to the operations budget.

PREVENTIVE MAINTENANCE BUDGET

Labor for Preventive Maintenance in the Past Year

Mechanic II	6,000 hours
Mechanic I	6,000 hours
Mechanic Helper	12,000 hours

NOTE: No adjustment required for changes in equipment.

Next Year's Projected Man-Hour Rates

Mechanic II	$8.00/hr x 6,000 hr	=	$ 48,000
Mechanic I	$6.00/hr x 6,000 hr	=	36,000
Mechanic Helper	$3.00/hr x12,000 hr	=	36,000
	TOTAL		$120,000

Add 5% to Labor Costs to Cover Added Wear and Tear on Equipment

$120,000 + 5% ($120,000) = $126,000

Preventive Maintenance Supply Costs Last Year

Lubricants	$ 2,500
Supplies	+12,500
TOTAL	$15,000

Add 5% to Cover Increases in Costs of Supplies & Lubricants

$15,000 + 5% ($15,000) = $15,750

Labor	$126,000
Supplies	+ 15,750
Preventive Maintenance Budget	$141,750

CORRECTIVE MAINTENANCE BUDGET

NOTE: Calculation similar to preventive maintenance budget calculation. Assume costs shown below were determined using procedure given for preventive maintenance budget.

Labor	$ 70,000
Supplies	25,000
Routine Repair Budget	$ 95,000

MAJOR REPAIR BUDET

Last year's projects	$ 50,000
Projects that will not be repeated this year	- 35,000
	$ 15,000
Projects in active backlog which will span the new year	20,000
Projects approved for next year	25,000
Forecast of next year's needs	5,000
Major Repair Budget	$ 65,000

TOTAL MAINTENANCE BUDGET

Preventive Maintenance Budget	$ 141,800
Corrective Maintenance Budget	95,000
Major Repair Budget	65,000
TOTAL MAINTENANCE BUDGET	$ 201,800

The budget and actual costs should be compared as the year goes on. Table 3 is an example of a monthly comparison made by one wastewater utility. This monthly comparison can be a very useful management tool. It enables you to find those areas where costs are different than budgeted. For example, there is (and has been) clearly a problem of spending considerably more for chemicals than planned. You would check to see if the cause is chemical prices being higher than planned or more chemicals being used than planned. In the example, it is a case of more chemicals being required for sludge dewatering than planned. The table points out that unless the problem is corrected, expenses for the year will be about $40,000 more than budgeted. This table quickly flags a major problem area which you would then study more thoroughly to find out:

- What is causing the high chemical usages (sludge characteristics different, overdoses of chemicals, etc.)?
- If the causes can't be corrected, can cuts be made in other costs to balance the budget or should a change in the budget be proposed to your board?

Graphical comparisons of monthly costs may also be useful in identifying differences in actual and budgeted costs.

Capital Budgets

The capital budget is based on a plan which defines the need for major construction contracts or equipment purchases for several years. Many utilities use a 5-year period for their capital budgets. You should ask each department to prepare a proposed budget which you can use in developing a system wide budget. Table 4 is an example capital budget for the vehicles used for a regional collection system and large land treatment system. Similar budgets would be prepared for treatment equipment and other major items, and then combined into a system wide capital budget.

EMERGENCY PLANNING

Emergency operating conditions can result from natural disasters, civil disorders, strikes, faulty maintenance, negligent operation, and accidents. These emergencies can cause equipment failures, power loss, blocked access, communications loss, and process failure. You should carefully analyze your system for several possible emergency conditions to determine the most vulnerable components of the system.

TABLE 3. EXAMPLE USE OF BUDGET COMPARISON FOR COST CONTROL - OPERATIONS AND MAINTENANCE EXPENDITURES COMPARED WITH BUDGET - JANUARY 1, 1978 THROUGH JUNE 30, 1978.

Object of expenditures	June actual	June variance favorable/ (unfavorable)	June year-to-date actual	Year-to-date variance favorable/ (unfavorable)	Budget fiscal 1978	Projected year-end fiscal 1978
Personnel	$29,500	$ 200	$180,000	$ 900	$365,000	$360,000
Materials & Supplies	8,200	(400)	32,000	(2,000)	60,000	64,000
Chemicals	11,000	(3,000)	70,000	(21,000)	92,000	140,000
Utilities	8,000	600	45,000	3,000	95,000	90,000
Outside Services	900	100	5,000	300	11,000	10,000
All Other Expenses	1,950	(50)	11,000	1,000	24,000	22,000
TOTAL O&M EXPENSES	$59,550	$(2,550)	$343,000	$(17,800)	$647,000	$686,000

TABLE 4. EXAMPLE CAPITAL BUDGET - FIVE-YEAR PLAN FOR VEHICLES

	Machinery description		Statistics from machinery to be replaced			
Year	To be replaced	Replacement	Original investment	Trade-in value	Replacement machinery cost	Cash needs
1976	Sta. wagon	Sta. wagon	-	-	$ 5,400	$ 5,400
1977	-	-	-	-	-	-
1978	4 trucks	4 trucks	$16,200	$ 4,100	23,700	19,600
1979	5 trucks	5 trucks	23,800	6,000	32,400	26,400
1980	Sta. wagon	Sta. wagon	5,400	1,400	7,300	5,900
	7 trucks	7 trucks	46,400	11,600	73,200	61,600

Total 5-Year Budget - $110,900
Average - 23,800

An important consideration in emergency planning is that you have trained someone in your basic duties and responsibilities. Your absence from the treatment facility, be it scheduled or not, may constitute the cause of the emergency if there is no one to take over while you're gone. It is your responsibility to see that there is backup for other critical jobs as well.

Some of the key steps which you can take to reduce the vulnerability of the system to various emergencies include having:

- A sound preventive maintenance and testing program
- Standby units and separation of vital elements
- Standby or alternative power supplies
- Alternate operating plans
- Adequate chemical supplies
- On-site storage of fuel and axuiliary power units, remote and/or automated controls, and ready conversion of automatic controls to manual operation
- Portable pumps with fuel-operated units
- Emergency and special operations training sessions

You should develop an emergency organization plan which spells out what each staff member is to do during an emergency. You should have mutual aid agreements with other nearby towns or other agencies or companies in your town. Such agreements can provide for equipment and supplies, personnel, and specialized skills during an emergency. For example, a local construction company may have tractors and backhoes which would be useful. The plan should include a system for listing such items and who to contact to obtain the equipment. The EPA report, "Emergency Planning for Municipal Wastewater Treatment Facilities," EPA Report 430/9-74-013 (10) and AWWA Manual M19, "Emergency Planning for Water Utility Management," (11) may be useful references for you.

INSURANCE

What type of insurance (in addition to types provided as fringe benefits for hospitalization, life, etc.) should the wastewater utility carry? Coverage for fire, explosion, wind, hail, and extended coverage should be considered. You need to determine which facilities should be covered, with what type of coverage, and the amount. To decide this, you should list all the plant components, their cost, and their susceptibility to damage. For example, you might analyze components as follows:

- Aeration tank:

Structure	$100,000
Contents (diffusers, etc.)	50,000
	$150,000

  The structure is open and below ground. There is no mechanical or electrical equipment involved. There appears to be no risk of loss due to fire, explosion, wind, or hail.

  Do not insure.

- Influent pumping station and contents:

Pump housing (reinforced concrete)	$ 80,000
Contents (pumps, piping, etc.)	70,000
	$150,000

  This item houses the influent pumps used in connection with the skimming tank. There is a remote possibility for gas to find its way into and to collect in this structure, therefore there is the potential for loss due to fire and explosion.

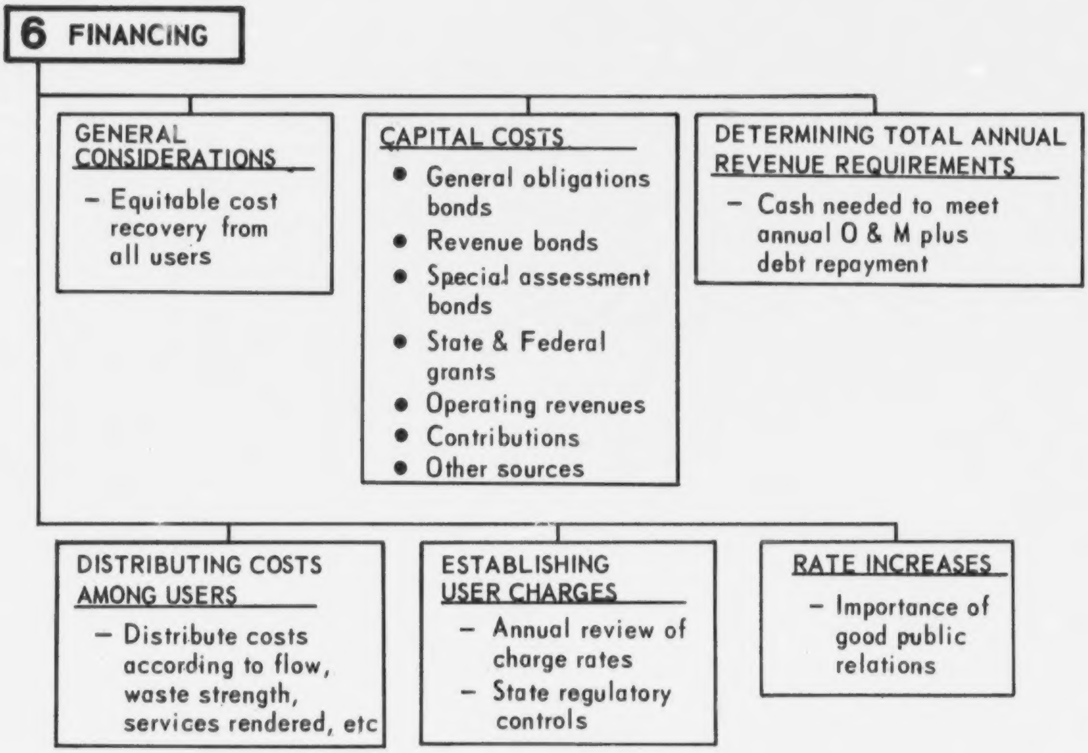
  Should be insured.

With this type of analysis, you can decide the value of items which may be subject to damage from insurable causes. (Most fire insurance policies extend coverage endorsements to cover losses from hail, windstorm, explosion, aircraft, and vehicles.) They usually do not cover losses from floods, water backing up through sewers or drains, groundwater exerting pressure on floors, earthquakes, losses resulting from nuclear reaction or radiation, losses due to equipment breakdown, or fire damage to electrical equipment when the fire was caused by a defect in the equipment such as a short in a motor winding. Flood and earthquake insurance can be obtained in many states although the costs may be high and the risks low.

Sometimes improved fire protection may lower insurance rates. Installing or increasing the number of fire hydrants may lower insurance rates enough to justify their cost. In some cases extending the city limits to include a plant may lower the rates. Competent insurance agents can inspect your plant and suggest changes which would lower rates.

Utilities should carry liability insurance (insurance covering personal injury and property damage) on all company-owned vehicles, including heavy mobile equipment, which is operated on public streets, alleys, highways, etc. If utilities and municipalities own and operate a lot of vehicles, there is some question as to whether or not collision insurance to cover damage to such vehicles can be justified. Operators of small fleets may feel justified in carrying both liability and collision insurance. You must use judgment to determine the coverage which you can reasonably afford.

Public liability, or general liability insurance, covers claims resulting from bodily injury to private persons and/or damage to private property. As an example, such an insurance policy might cover claims of bodily injury and perhaps property damage resulting from a major explosion in a sewer main. Policies and policy endorsements for public liability insurance are available to cover almost any and all risks. The types and amounts of coverage to be carried are dependent on the risk which you wish to assume and are again a matter of judgment.



6 FINANCING

GENERAL CONSIDERATIONS
- Equitable cost recovery from all users

CAPITAL COSTS
- General obligations bonds
- Revenue bonds
- Special assessment bonds
- State & Federal grants
- Operating revenues
- Contributions
- Other sources

DETERMINING TOTAL ANNUAL REVENUE REQUIREMENTS
- Cash needed to meet annual O & M plus debt repayment

DISTRIBUTING COSTS AMONG USERS
- Distribute costs according to flow, waste strength, services rendered, etc

ESTABLISHING USER CHARGES
- Annual review of charge rates
- State regulatory controls

RATE INCREASES
- Importance of good public relations

SECTION 6

FINANCING

GENERAL CONSIDERATIONS

Both good management practice and federal law require that the revenues needed to operate a publicly owned wastewater utility be collected from the users in proportion to the benefits that each receives. As the cost of wastewater treatment and general tax rates increase, opposition to taxes traditionally used to pay for wastewater treatment has become widespread. The Clean Water Act of 1977 restricts the use of general property or ad valorem taxes to cases where these taxes were used for wastewater system revenues as of December 27, 1977, and where the system including the taxes, results in operation, maintenance, and replacement costs being distributed proportionately among all classes of users. Because of these factors, it has become common to recover most of the operating and maintenance costs through a system of service charges. Capital costs are usually funded through a combination of federal and state grants and various types of bonds. You may want a consulting engineer or a financial consultant to help develop a detailed financial plan for your system.

The purpose of this section is to acquaint you with some of the considerations and alternatives involved in financing your system. This will allow you to contribute to the development of your financial plan and to better explain the basis of sewer service charges to your customers.

CAPITAL COSTS

Most of the local share of major capital expenditures is normally met through the sale of bonds. These bonds may be sold so that they all are payable at one time or so that some are due each year over a period of several years. This second case is the most common because this type of bond is more flexible in the bond market, making it easier to meet the debt service requirements. Bonds are usually sold for a term about equal to the useful life of the facilities involved, typically 20 to 30 years. A very short term places too much burden on the initial users. A term longer than the useful life of the facility is unfair to future users because they will be paying for replacement facilities while still paying for the original facility.

The types of bonds commonly used include general obligation bonds, special assessment bonds, and revenue bonds. The part of the capital costs not financed through bonds is usually funded through state and federal grants, operating revenues, or contributions (12).

General Obligation Bonds

General obligation bonds are backed by the full taxing power of the issuer. That is, the issuer can use ad valorem (general property) taxes to repay the bonds. Such bonds become a part of the overall municipal debt. This debt is usually limited by law to some percentage of the total assessed valuation of taxable property. Some states also regulate the rate at which such bonds become due to insure that not too much of the debt is passed on to later generations. In many cases, the sale of general obligation bonds requires a bond election. General obligation bonds have several advantages:

- Interest rates are lower because they are backed by the full credit of the community.
- The security feature usually enables public sale at attractive terms.
- Overhead costs for financing are usually less because they do not require the detailed documentation needed for revenue bonds.
- Although the ability to use general taxes makes the bonds attractive, they can also be repaid with service charges which comply with the Clean Water Act requirements for user charges.

In some cases, where the revenues from user charges are pledges to repay the bond, the bonds may not have to be included in the local bonding limit. When the local bonding limit is approached, then other means such as revenue or special assessment bonds are needed for long term capital funds (13). If your community has a local bonding limit, it may have been established in the original charter, amendments to the charter, or by state law. The limit is often set as a percentage of the assessed valuation. Your city manager should be able to provide information regarding this matter.

Revenue Bonds

Many cities and districts have the right to issue revenue bonds specified in their charter or under state law. Before considering this alternative, it is important that your attorney confirm your legal ability to issue the bonds. Revenue bonds for a system with a history of sound management can be sold at favorable terms. There are usually no legal limits on the amount of revenue bonds which can be issued; however, excessive offerings represent high risks to investors. User charges from the wastewater system are used to repay revenue bonds. Revenue bonds have advantages since:

- They are not included in legal debt limitations.
- They usually do not require voter approval.
- They can be used to finance projects beyond the boundaries of a city or district.
- In some cases, revenues from a long established water utility can be pledges to a wastewater bond issue if both utilities are operated by the same entity.

One difficulty with selling revenue bonds for entirely new systems is that there is no established record of earnings. Another is the fact that net revenues must be somewhat higher than are actually necessary to repay the bonds. This margin over the debt requirements, termed "coverage," varies with the risk of the issue from 20 to 50 percent. The margin is intended to protect against unplanned costs or lack of planned revenues.

Special Assessment Bonds

Special assessment bonds can be issued when only certain properties are served as in the case of sewers, where the benefits to individual properties are obvious. The assessments are usually made on front-footage or area.

The bonds are not payable from general taxes, but rather by benefit assessments. Because the bonds are not backed by general taxing authority, they are considered a greater risk by investors than general obligation bonds. As a result, they usually have higher interest rates. The actual rate depends chiefly on protective features provided, such as provisions for enforcing collections, the status of the lien relative to other liens, or penalty provisions for unpaid assessments which can be used to build up a reserve. Because of the higher rates paid for assessment bonds, many local governments borrow construction capital general obligation bonds which are repaid through special assessments.

State and Federal Grants

The EPA construction grant program has provided billions of dollars for construction of publicly-owned wastewater treatment plants. Five billion dollars per year have been allotted for fiscal years 1979 to 1982. The regulations concerning grant eligibility of various components of a system are lengthy, subject to frequent revision, and will not be reviewed here. Your consulting engineer or state pollution agency can be contacted for current grant regulations if you are attempting to determine if a certain construction project is grant eligible. Recent changes restrict the grant eligibility of collection lines. Certain types of projects using new approaches may be eligible for an 85 percent federal construction grant rather than the normal 75 percent. In many states, the state pollution agency provides grants for portions of the remaining 15 to 25 percent.

In addition to the EPA construction grant program, there are other federal agencies which may make grants or loans. Because the details of these programs also change frequently, it is not practical to present details of each program. The following agencies may have current programs which may be of value to you. The Farmers Home Administration has a program, "Financial Assistance to Small Towns and Rural Groups," which may provide grants to small (5,500 population or less) rural towns or villages. The Department of Housing and Urban Development can provide long-term (40-year) loans to finance construction of all types of public works when such credit is not otherwise available on reasonable terms.

Operating Revenues

It is common practice for publicly-owned wastewater utilities to use some funds derived from revenues for routine system extensions, replacements and modifications, or improvements at the treatment facility. In many cases, fixed amounts are set aside each year in a capital improvement fund for such purposes. This practice permits budgeting on an orderly, even basis and allows occasional, large capital expenditures from operating revenues.

However, caution should be exercised in using a current surplus for the total cost of constructing major facilities which will be useful for many years. A fair share of the cost of facilities should be borne by all users, present and future.

As noted earlier, operating revenues from user charges can also be used for repayment of general obligation bonds.

Contributions

In some instances, customers are required to pay the total capital cost of facilities. An example of this is lateral sewers constructed at the builder's cost in new developments. In this case they would be required to make a contribution to cover the cost of the system extension.

Other Sources

Although not frequently used for financing wastewater utilities, you should not overlook the possible use of local taxes on income, sales, liquor, cigarette, and hotel/motel occupancy. A resort area may find, for example, the hotel/motel occupancy tax to be especially fair since a significant part of the cost of the treatment plant may be related to the capacity needed for the peak tourist season.

Another common source of capital funds is short-term notes. These notes are usually issued during the early stages of a project to cover cash flow. They are usually repaid through long-term general obligation or revenue bonds. The short-term notes permit placing a long-term issue on the market at a time when interest rates are favorable; they provide time to determine total costs before proposing a major bond issue.

DETERMINING TOTAL ANNUAL REVENUE REQUIREMENTS

The total annual revenue requirement for a publicly-owned wastewater treatment system is the amount of cash needed to meet the costs of operating and maintaining the system and for improvements not covered by debt financing, as well as paying the debts.

The debt requirements include the principal, interest, and reserve payments, if any, and are usually payable in annual installments. Obviously, enough cash must be collected to pay the installments when they are due.

Revenues must also be collected to pay operation and maintenance expenses such as salaries, power, fuel, maintenance supplies, chemicals, insurance, professional services, fringe benefits, etc.

In addition, it may be necessary to raise cash for capital items not covered by long-term debts such as trucks, replacement of broken service lines, and equipment replacement. There also may be taxes which must be paid.

The following example shows how the local revenue requirements may be estimated for an example 5 mgd activated sludge plant and collection system:

Initial cost	$7,885,000
Federal construction grant (on plant construction of $5,885,000 only)	$4,413,750
Local capital cost funded with revenue bonds at 7% interest for 20 years; equal annual installments of	$ 327,650
Debt coverage requirement = 20% x $327,650	$ 65,530
(Specified in the bond issue to provide a margin of safety in generating annual revenue for debt service.)	

Annual operating expenses	
Labor	$ 155,470
Power	31,360
Fuel	36,000
Maintenance Materials	47,340
Chemical (chlorine and polymer)	81,100
TOTAL	$ 351,270

Reserve fund for plant replacements, modifications, repairs not included in operating expenses or in original bond issue	$ 25,000

No tax payments
The total annual revenue requirements would then be:

Debt service, principal and interest	327,650
Debt service, coverage	65,530
Operating expenses	351,270
Reserve fund	25,000
Taxes	0
TOTAL	$ 769,450

The above example assumes that the debt repayment schedule is based on a series of uniform annual payments. Some bond issues may have a repayment schedule which results in different amounts being due each year.

DISTRIBUTING THE COSTS AMONG USERS

The following general principles determine the allocation or distribution of costs to the users of the system:

- Operating expenses for treatment plants are primarily related to the volume and strength of the wastewater received. Undeveloped sewered properties do not contribute to treatment operating costs. These costs should be recovered from the current users of the system. Where there is only one class of user (all domestic), the costs are directly related to flow. In the case where an industrial waste enters the system, the difference in waste strength must be considered in allocating costs.

- Operating expenses for separate sanitary collection systems are primarily related to flow from each user. For a combined sewer system, some costs are related to runoff from undeveloped property.
- Capital costs for the treatment facility are primarily related to the waste loads from the existing users although undeveloped property should share in the cost because some reserve capacity has been built for future service to these properties.
- Capital costs for the collection system should be shared by all property owners since undeveloped lots as well as current users both benefit from the system.

To determine the responsibility of each customer class for costs of service, it is necessary to allocate each element of plant investment and operating expense.

Costs related primarily to flow of wastewater include operating and capital costs for a majority of collection system costs and certain treatment costs.

Some costs of treatment are affected by the strength of wastewater to be treated. These costs may be further separated into costs that vary with BOD, suspended solids, and, in certain instances, nitrogen and phosphorus. Appendix A presents an example to illustrate the methods which can be used to distribute costs.

ESTABLISHING USER CHARGES

EPA regulations require that user charges be reviewed annually and revised as needed to reflect actual O&M costs. Even if you have an established sewer service charge structure, you must be prepared to evaluate the charges on a regular basis. Appendix A gives an example showing how user charges may be set after the costs are distributed.

Individual homes do not have meters to determine wastewater flow. One common approach is to base the wastewater charges on a percentage of the metered water flows. For example, if the average domestic water demand were 4.0 mgd for an average domestic sewage flow of 3.25 mgd, the wastewater billings could be based on a flow of 81.25 percent (3.25/4.0) of the metered water flows. In areas where there is extensive warm weather irrigation, the charges can be based on the average water use during only the non-irrigation months or some other representative period.

For example, at Stevens Point, Wisconsin (14), the charge structure specifies that "The amount of water used by residential customers during the winter quarter of each year shall be used as a basis for determining the maximum sewage-service charge for that particular quarter and the three succeeding quarters." The ordinance also states that if the usage at any time falls below the winter quarter volume, the customer's bill for that particular period will be the smaller amount. Painesville, Ohio, requires that the monthly sewer bill during June, July, and August not exceed the maximum sewer service charges for the first five months of the year. Those rates which exempt three of the summer months from the meter readings are not completely fair to the customer who uses large quantities of water to start a new lawn before or after this exempt period.

EPA regulations also permit user charges based on a percentage of water bills in cases where the water is based on a constant cost per gallon.

In cases where the water usage is not metered, several approaches have been used in establishing user charges based on size of water connection; number and type of water-using fixtures such as toilets, sinks, garbage grinders, showers, bath tubs, etc.; number of rooms, etc. "Municipal Sewer Service Charges," available from American City Magazine, describes many alternate approaches.

The example in Appendix A gives a better understanding of the factors to consider in setting rate structures. This example only illustrates how the factors may be considered in establishing an equitable rate structure. You may need a qualified consultant to help develop a plan for your specific community.

RATE INCREASES

The rates charged by most privately-owned utilities are controlled by state regulatory commissions. However, the rates of most public utilities are not subject to state control and may not even be subject to court review. Even without this regulation, you must still have a properly designed rate structure.

Since the public is likely to be against an increase in sewer service charges (or even a change in the rate structure), a carefully planned, long-term public relations program (see Section 9) is needed to meet this opposition. A good public relations program will have informed the public of the value of the services you provide. Without this understanding, strong public opposition is likely when a change in service charges is announced. Doing a good job and letting the public know about it are important to the acceptability of rate increases.

Most public utilities hold public hearings on proposed rate changes before a adopting them. This provides a chance to educate the public as to the need for change and for public input in setting up the new charges. However, a *very* small percentage of customers will attend such hearings. The majority of the public will not be heard from until they receive the notices.

Before notices of rate changes are mailed to the customers, it is wise to have an educational program in the local news media. As with the hearing process, this will reach only a minority of your customers. Only the receipt of the next bill will get the attention of all of your customers. The notices of the rate increases or changes should accompany this bill. The notice must be carefully prepared in a courteous tone. A harsh, cold notice merely stating that the rates have changed will cause resentment. The notice should explain the need for the change in a simple manner. Put yourself in the shoes of the customer and ask "How would I react to this notice?"

Try to anticipate the need for a rate change well in advance (i.e., operation of an expanded plant, higher levels of treatment, etc.) so that you can plan the timing of the notices. If possible it is wise to announce rate changes at a time when they will not be confused with other local issues such as hearings on a new wastewater facility plan, a local property tax change, or other local election issues. Avoiding these other issues may reduce the spillover of emotions from unrelated local issues to your sewer service charges.

7 EVALUATING STAFFING NEEDS

GENERAL CONSIDERATIONS

- Understaffing
- Overstaffing
- Contracting services

DETERMINING STAFF SIZE

- Labor requirements
- Level of utilization
- Classification
- Shifts

DETERMINING THE QUALIFICATIONS AND SKILLS NEEDED

- Organization charts
- Job descriptions

CERTIFICATION PROGRAM

- Mandatory
- Voluntary
- Advantage

TRAINING PROGRAMS

- Types:
  - Preparatory
  - Skill management
  - Skill improvement
- On the job
- Miscelleneous

SAFETY PROGRAMS

- **Responsibilities:**
  - Provide safe place
  - Provide safe tools & equipment
  - Hire qualified personnel
  - Train workers in safe practices
- **Accident report forms**

SECTION 7

EVALUATING STAFFING NEEDS

GENERAL CONSIDERATIONS

Selecting the right sized staff with the proper skills is critical. Understaffing may eventually cause increased costs from lack of needed maintenance, poor treatment process performance, and poor morale among employees who are overworked. Overstaffing is expensive. Layoffs of extra staff are not only painful to the individuals who lose their jobs, but are also expensive. You may have spent a lot of time and money to train the employee. Deciding who is going to be laid off often runs into personnel complications, union rules, and union contract conditions. Reductions in staff may cause strikes and other disruptions and troubles. Unemployment compensation may be costly. Both hiring and firing are costly.

For all of these reasons, use great care before you establish any new position that might become a "permanent" one. When there is any doubt, either don't create the position or establish it on a temporary basis. When a position becomes vacant, ask yourself if the position is really necessary. Consider these factors:

- Conservation of manpower
- Elimination of unnecessary work
- Full use of manpower
- High costs of manpower
- Dangers, costs, and complications from overstaffing

If you are now contracting for certain work, such as lawn maintenance or instrumentation maintenance, you should not ordinarily give up this method to permit your work force to do the work. Any temporary gain in savings will probably be eaten up in the long run by rising labor costs. The trade-offs between contracting for services and doing them in-house should be carefully examined. If specialized skills are needed on a short-term basis, it may be most economical to hire a consultant; however, a premium price may be paid for consulting services over an extended period of time.

DETERMINING STAFF SIZE

There are several methods used in planning the staffing requirements for wastewater treatment facilities. These are reviewed briefly and their limitations identified.

Determination of Labor Requirements

Comparison with Other Facilities--

One of the most common methods is to review the staffing level at similar, operating facilities (15). This approach will identify differences between your staff level and what is "typical" for other facilities.

The major shortcomings of this approach are that the mistakes of past can be repeated, operational differences and differences in job functions are not easily compared, and the productivity of the staff is not reflected. However, this method does provide a "first cut" estimate of staffing level.

Staffing Guidelines--

Published staffing guidelines take two general forms: curves showing total staff size as a function of wastewater flow, or a series of curves showing the labor requirements for different unit processes as a function of wastewater flow or a basic design parameter for that process.

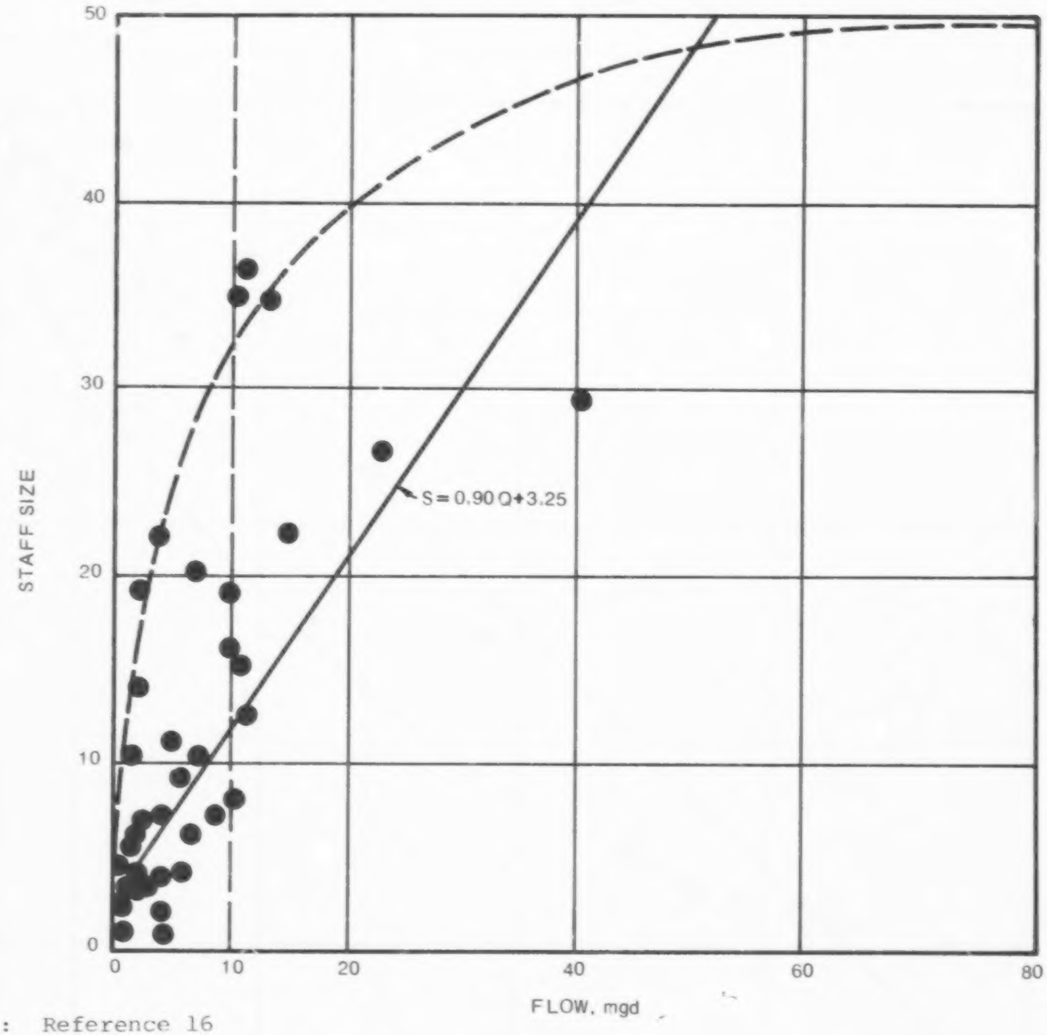
The first type does not improve on the method of comparing staffing levels with other operating facility. Examples of this method are included on Figures 7, 8, 9, and 10. These curves do not reflect differences between the types or sizing of processes for liquid or sludge handling at different plants. They provide only a "first cut" estimate of staff size. The scattered data points indicate variation in staff size for a particular flow. It should be noted that most of the data points for these graphs fall below flows of 10 mgd.

The second type of guideline is a better method. This method (17) involves listing the unit processes at the treatment facility. The labor requirements for each process at the plant can be estimated from curves or tables and then added together to determine the total annual labor requirement.

Published staffing curves based on unit processes are plotted in terms of either the design flow or a basic design parameter. Curves based on flow would be accurate if all design engineers used the same criteria for sizing the various processes. This does not happen. Therefore, some uncertainty of staffing estimates results from curves based on flow. However, such unit process curves can provide improved estimates for a particular facility.

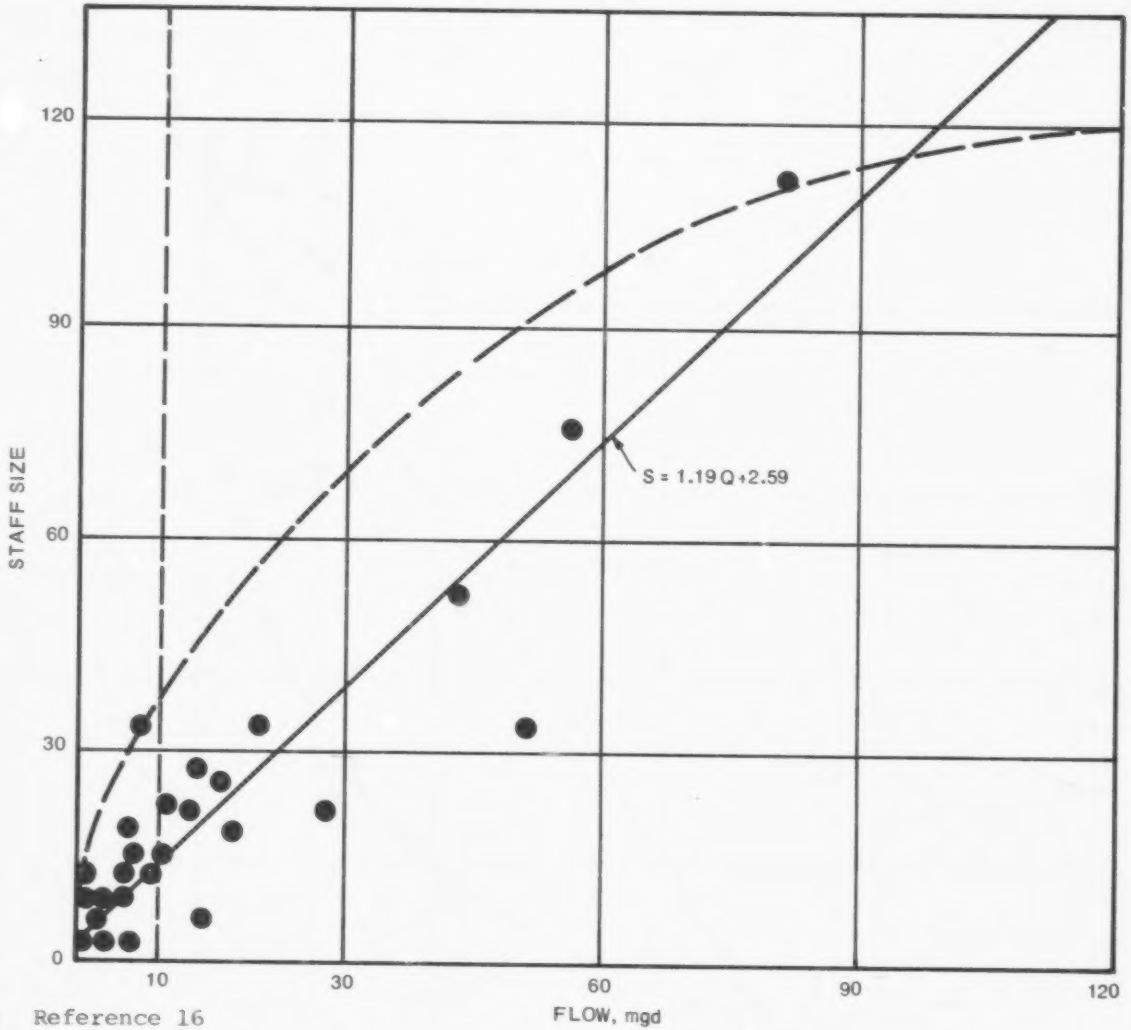
The labor requirements from individual process curves plotted as a function of a basic design parameter result in even more accurate estimates, since the actual sizes and types of the individual processes are considered.

Examples of the two types of unit process curves are shown in Figures 11, 12, and 13. Figure 11 shows the labor requirements for primary sedimentation and raw sludge pumping based on average plant flows. Figures 12 and 13 show the labor requirements based on basic process design parameters. Some of these curves divide the total labor requirements into operation and maintenance. Inspection of the curves shows the basic differences between the approaches. For example, when you consider 10 mgd primary sedimentation basins designed on the basis of overflow rates of 600 or 1,200 gpd/sq ft, the following results are obtained:



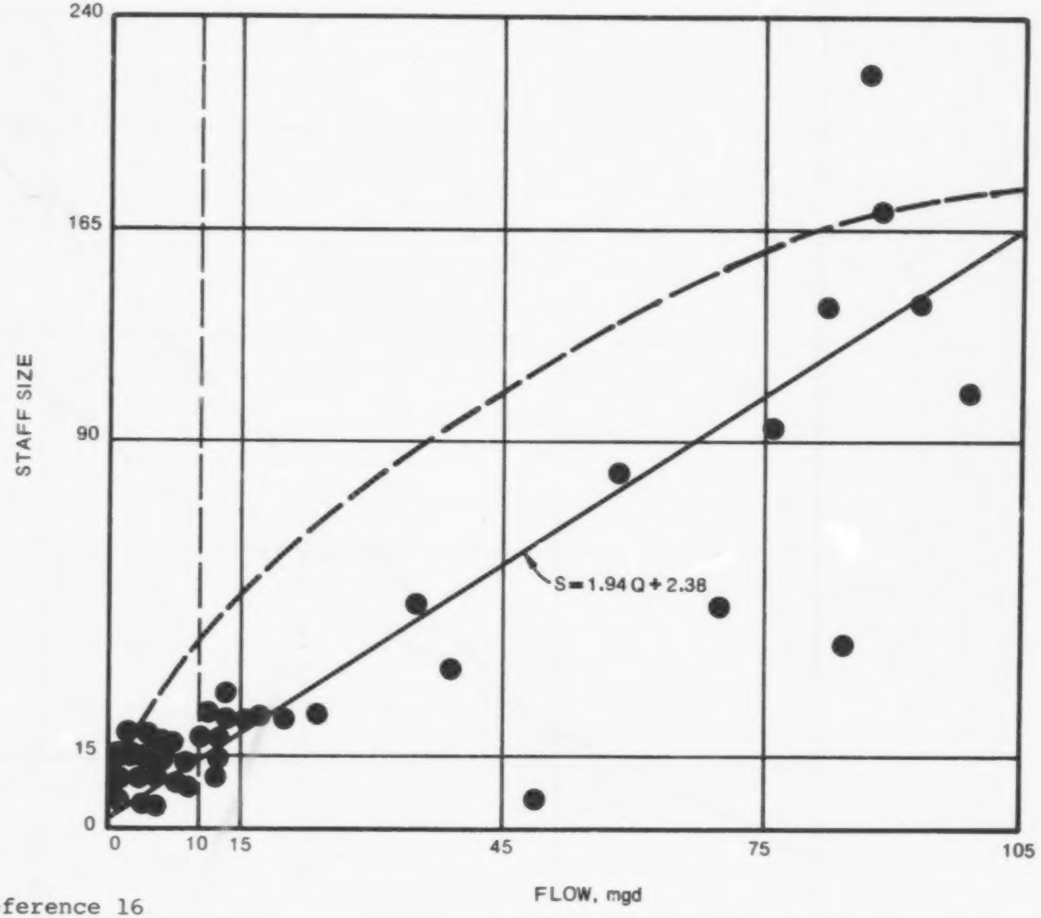
Source: Reference 16

Figure 7. Staff size vs. actual flow - primary treatment.



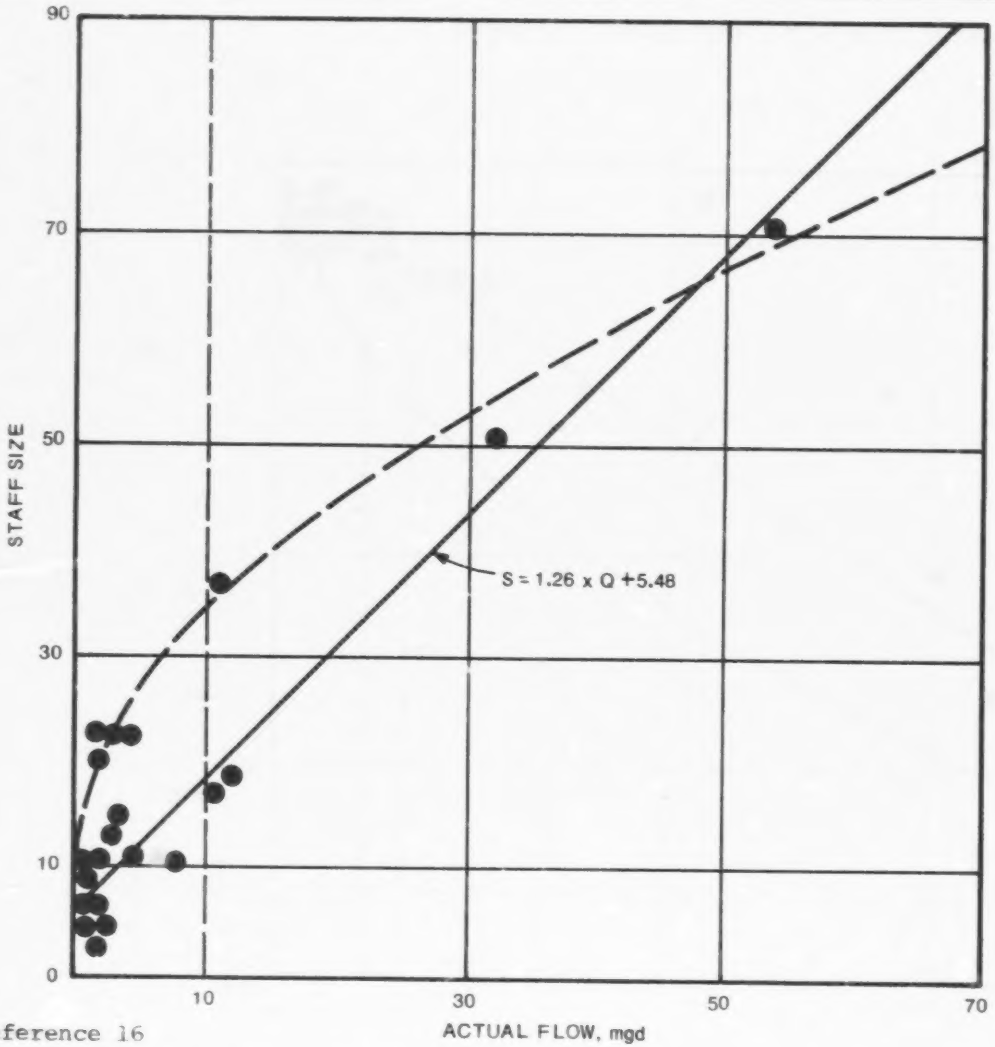
Source: Reference 16

Figure 8. Staff size vs. actual flow - trickling filter.



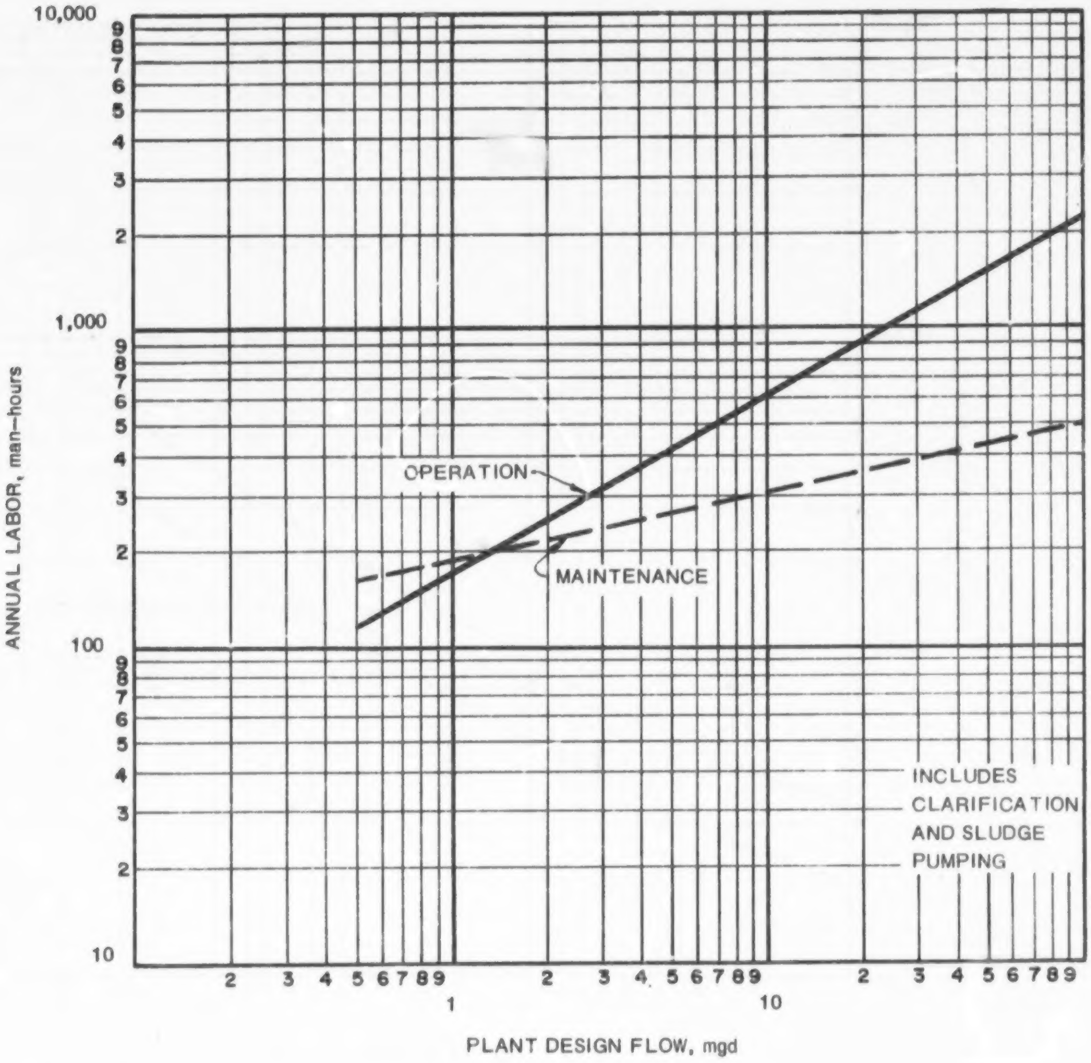
Source: Reference 16

Figure 9. Staff size vs. actual flow - activated sludge.



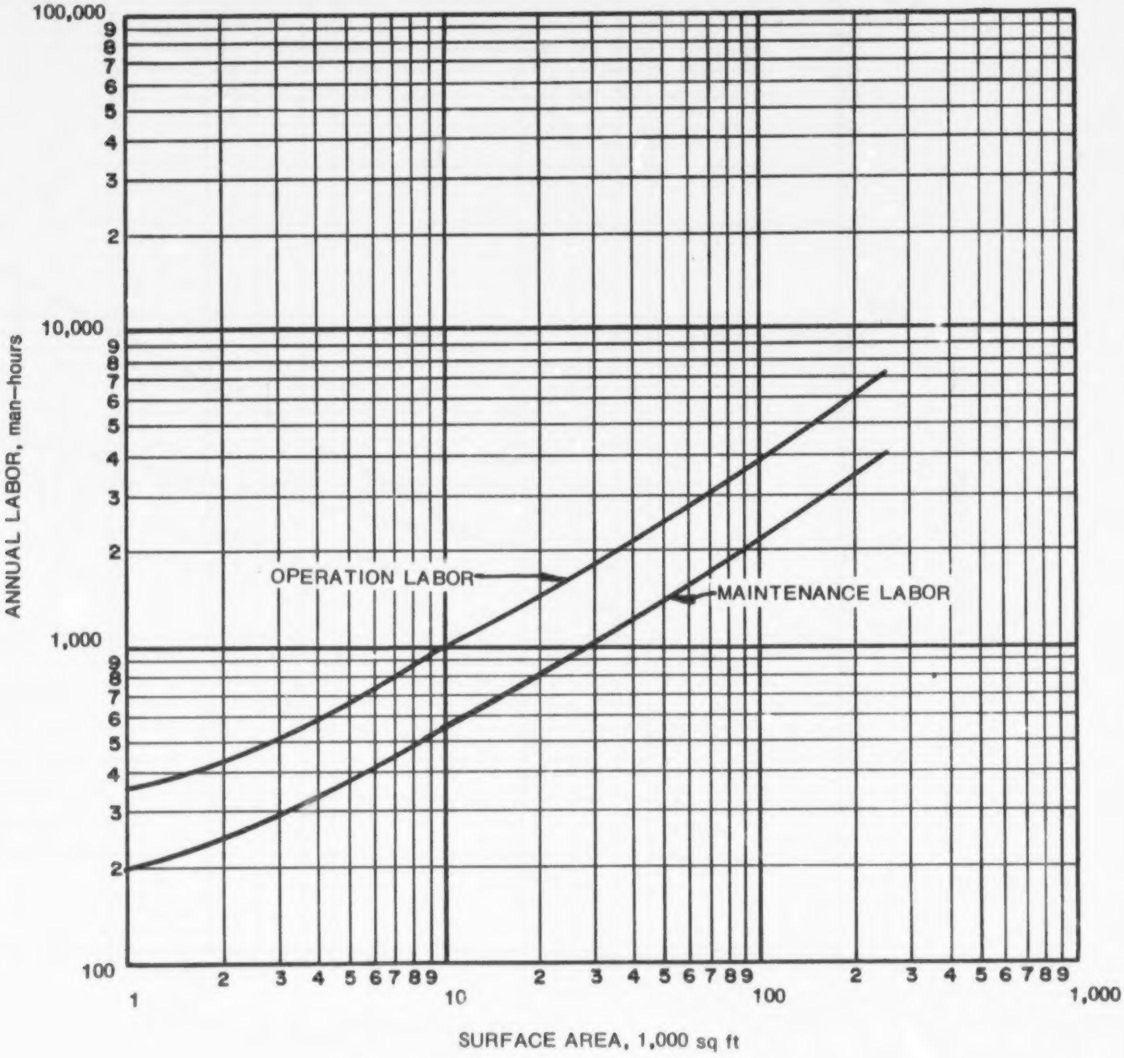
Source: Reference 16

Figure 10. Staff size vs. actual flow - advanced treatment.



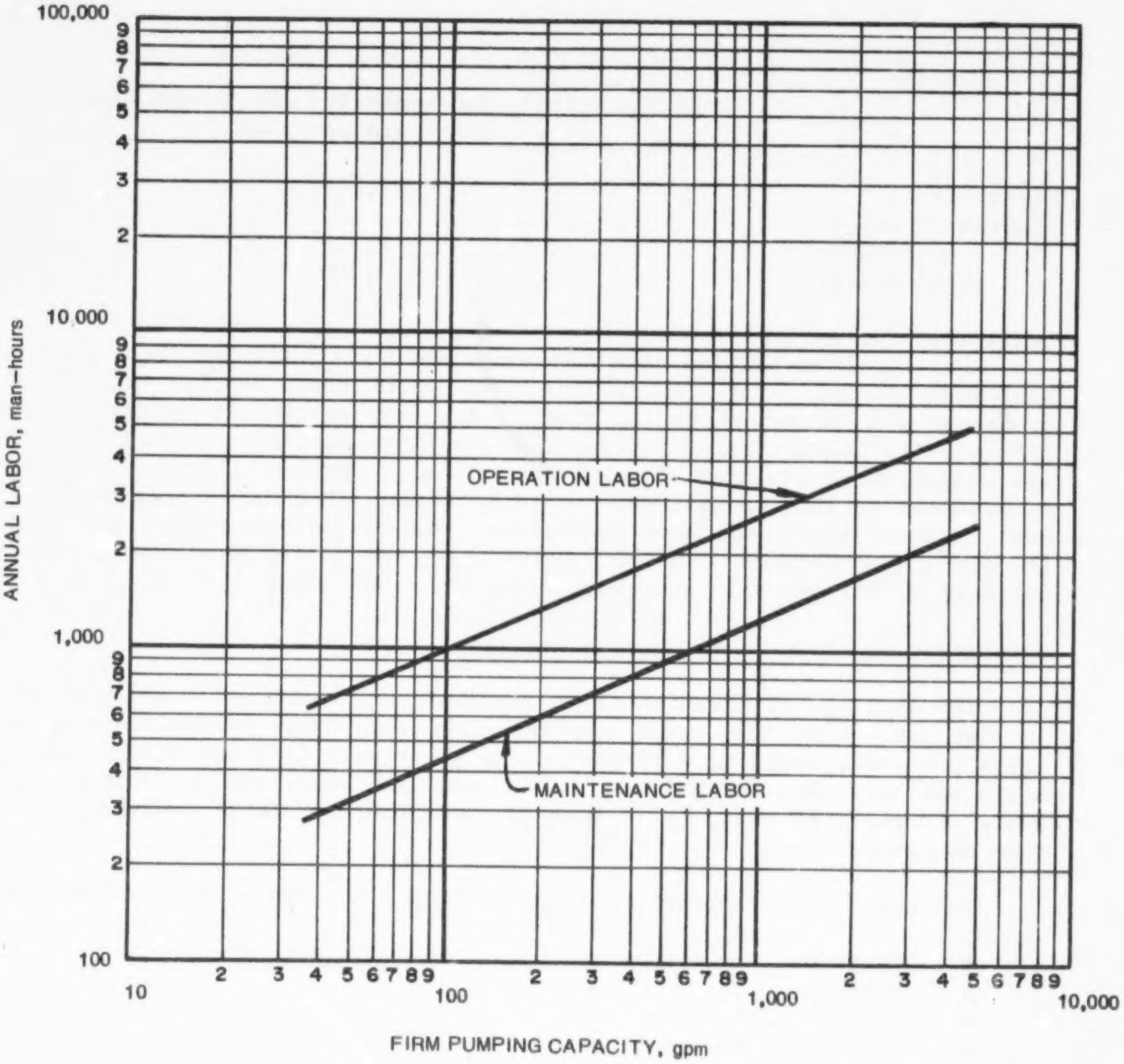
Source: Reference 18

Figure 11. Labor requirements for primary sedimentation.



Source: Reference 19

Figure 12. Labor requirements for sedimentation.



Source: Reference 19

Figure 13. Labor requirements for primary sludge pumping.

	10 mgd Primary Sedimentation and Sludge Pumping, man-hours per year
Figure 11	2,700
Figures 12 and 13	
600 gpd/sq ft	2,100
1,200 gpd/sq ft	3,200

Individual Evaluation--

Individual evaluation requires experience with all the unit processes and equipment at the plant. To do this, you would start by listing all the unit processes and operations at the plant. For each process or operation, you would list all the operational functions that would be carried out each day. Based on the equipment manufacturers' recommendations, a similar list for the preventive maintenance of all the equipment would be needed. Based on a combination of judgment, common sense, and past experience, you can estimate the time required to perform all activities listed. The sum of the labor requirements provides an estimate of the overall labor requirements for the plant.

Determination of the Level of Utilization

The level of utilization is an estimate of the actual productive time spent on the job. Productive time is less than the total available time of 2,080 hours per year, based on a 40-hour week. One report (19) has placed this at 1,872 hours per year, another (18) at 1,500 hours per year, and a third at 1,550 (15) hours per year. However, it is best to determine the value individually for each type of plant.

The main items to consider in estimating the level of utilization are:

- Vacation
- Holidays
- Average sick leave
- On-the-job training
- Safety and other meetings
- Productivity factor (accounts for such items as picking up equipment off the plant site, coffee breaks, discussion groups, area coverage, and other miscellaneous lost time items)

The first three items are easily determined. Safety and other meetings can be estimated. On-the-job training should be planned, the time required can then be estimated. Training generally accounts for about 1 to 3 percent (20 to 62 hours per year) for typical secondary plants and about 3 to 5 percent (62 to 104 hours per year) for complex advanced treatment plants. Discretion and judgment should be used in determining the requirments. During start-up of a new plant or an upgraded plant, training requirements for the first year may reach as much as 10 percent (208 hours per year) of the annual available time.

Other items that may reduce productive time include off-site travel for parts and equipment (which could be significant if the plant is some distance from the nearest major city); plant coverage, which is related to the general layout of the plant and the distance between various processes and equipment; and coffee breaks and discussion groups.

An example of a level of utilization computation is shown in Table 5. The numbers are typical, but are not based on any specific plant. The annual hours (1,656 hours) represent the time available for plant operation and maintenance from each employee. Therefore, to determine the total staff required, the annual labor requirement (in man-hours) would be divided by 1,656 hours. Once the total number of people required for the plant is determined, then an organization can be established.

TABLE 5. LEVEL OF UTILIZATION DETERMINATION

Item		Hours
Annual vacation		80
Paid holidays		80
Average sick leave taken		56
On-the-job training		50
Safety meetings		6
Miscellaneous meetings		2
Off-site travel, plant coverage, coffee breaks		150
	TOTAL	424
Annual hours available (52 wks x 40 hrs - 424 hrs)		1656

Determining Number of People by General Classification

The people required for plant operation will fall into the following five general categories:

- Administration
- Laboratory
- Site work
- Operation
- Maintenance

The number of personnel required for plant administration and site work can be estimated from individual published curves. The curves for plant administration are usually based on plant flow. The results from the curves must be adjusted to reflect the actual management structure. For example, if the plant is owned and operated by a city, town or community, the administration requirements are usually lower than if the plant is in a separate district. With a separate district, more administrative staff are required for accounting, monthly billing and other work that would normally be handled by the city staff.

The labor requirement for laboratory operation is directly dependent upon the number of samples taken per year and the number of tests conducted on each sample. An estimate of the time can be obtained from published curves, such as the one in Figure 14. For a more detailed evaluation, the time required for each test can be used to estimate annual labor requirements. The number of tests depends on many factors, such as the variability of flow, the NPDES permit requirements, the amount of in-plant testing necessary to operate the plant efficiently, and any other testing completed for historical reasons or to determine plant efficiency.

The level of laboratory staffing can also be estimated using data from another EPA report (8). This report has recommended staffing requirements as a function of plant design flow and the level of treatment. The annual hourly labor requirement can then be adjusted using factors for local conditions.

The two remaining categories are for the operation and maintenance personnel. Some of the guidelines have separate curves for operation and maintenance labor for each unit process. For those curves with a single value for both operation and maintenance requirements, the ratio of personnel in each category can be affected by several factors:

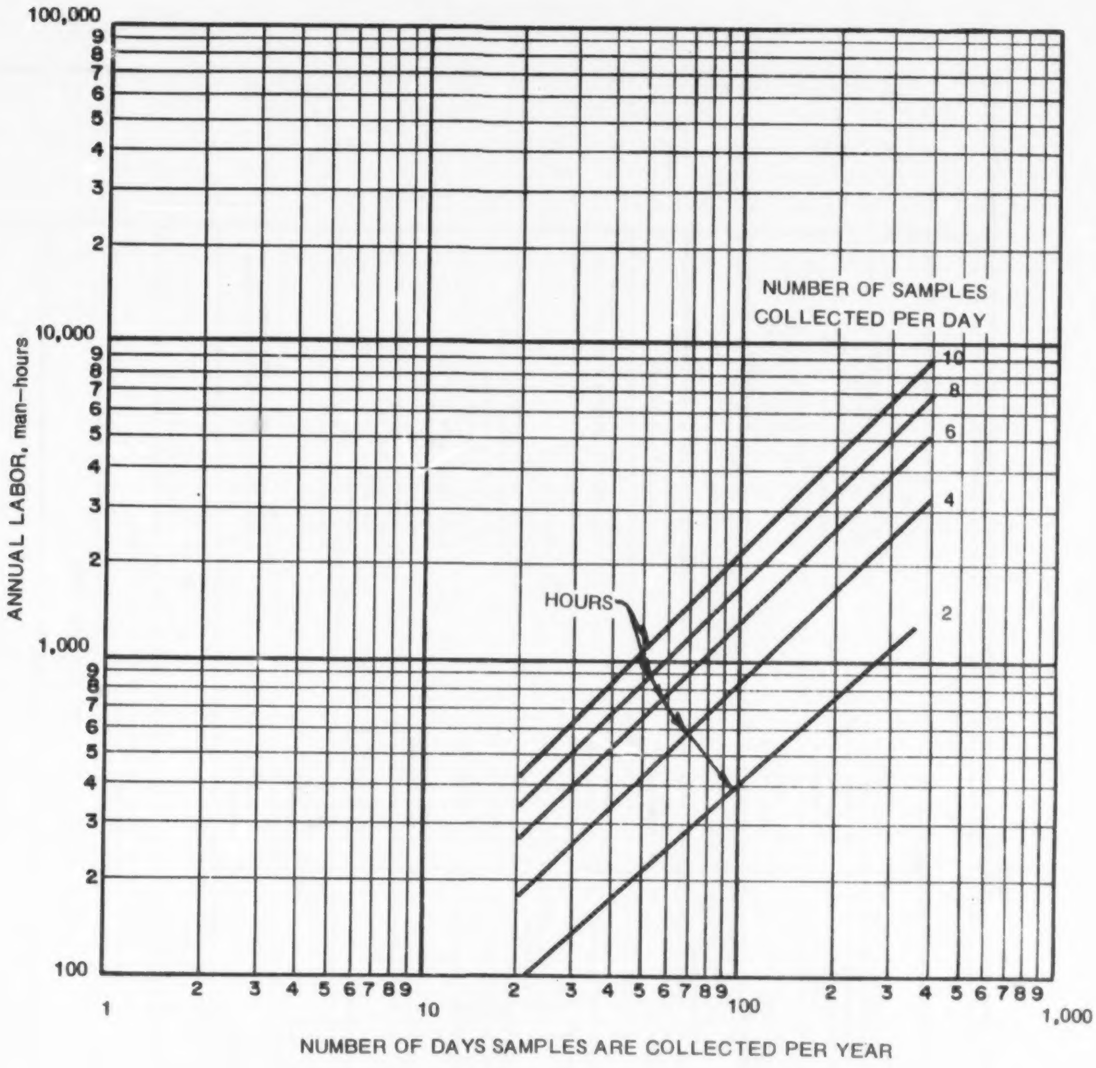
- Capacity of facility
- Type of treatment process
- Complexity of equipment
- Plant layout
- Climate
- Variability and strength of influent wastewater
- NPDES discharge standards

As a general rule, as flow increases, the percent of labor for operation decreases. Typical ratios are about 70/30 (70 percent operation, 30 percent maintenance) for mgd and 60/40 for 10 mgd plants. The effects of other factors have been estimated as shown on Figure 15.

Although the use of adjusted curves can give good estimates, local factors and past experience are the best sources of information for making labor estimates.

Shift Coverage

The decision of whether to provide partial or full shift coverage can be a difficult one. The total number of staff for shift work is the number in each position on the shift times a factor, which depends on the level of utilization.



Source: Reference 20

Figure 14. Labor requirements for laboratory.

LOCAL CONDITION	ADJUSTMENT		
PLANT LAYOUT	COMPACT *Yardwork – 50%* *Operations, maintenance – 10%*	AVERAGE *No adjustment*	EXTENDED *Yardwork + 50%* *Operations, maintenance +10%*
UNIT PROCESSES	STANDARD EQUIPMENT, SAME MANUFACTURER *Maintenance – 10%*	STANDARD EQUIPMENT, DIFFERENT MANUFACTURERS *No adjustment*	NON–STANDARD EQUIPMENT DIFFERENT MANUFACTURERS *Operations, maintenance + 10%*
LEVEL OF TREATMENT	PRIMARY *Supervisory, Clerical* *Operations – 40%* *Laboratory – 20%* *Yardwork – 10%*	SECONDARY *No adjustment*	ADVANCED *Supervisory, Clerical* *Laboratory +2%/AWT process* *Operations +10%* *Maintenance – 20%* *Yardwork +10%*
TYPE OF WASTE REMOVAL REQUIREMENT	PERCENTAGE OF WASTE REMOVAL SUCH AS '85% REMOVAL OF BOD' *No adjustment*	AMOUNT OF WASTE IN EFFLUENT, SUCH AS 'NO MORE THAN 20 MG/L BOD' *Laboratory +10%* *Operations +5%*	
INDUSTRIAL WASTE	NONE OR CONSTANT *No adjustment*	SEASONAL *Operations +5%*	ERRATIC *Laboratory, Operations +10%*
PRODUCTIVITY OF LABOR	HIGH *Operations, maintenance –15%*	AVERAGE (6½–HR/DAY) *No adjustment*	LOW *Operations, Maintenance + 15%*
CLIMATE	MODERATE WINTERS *No adjustment*	EXTREME WINTERS *Maintenance +10%*	
TRAINING	CERTIFICATION AND CONTINUING EDUCATION *Supervisory – 10%* *Operations – 5%*	CERTIFICATION BUT NO CONTINUING EDUCATION *No adjustment*	NEITHER CERTIFICATION NOR CONTINUING EDUCATION *Supervisory, Operations +10%*
AUTOMATIC MONITORING	NONE *Operations +5%*	MONITORING ONLY *No adjustment*	MONITORING WITH FEEDBACK *Operations – 5%* *Maintenance +5%*
AUTOMATIC SAMPLING	NONE *Laboratory, Operations +5%*	OF INFLUENT AND EFFLUENT *Laboratory, Operations – 5%*	THROUGHOUT PLANT *Laboratory – 10%* *Operations – 5%*
OFF–PLANT LABORATORY WORK	NONE *No adjustment*	FOR RECEIVING–WATER MONITORING ONLY *Laboratory – 10%*	FOR ENTIRE PLANT *Laboratory – 100%*
OFF–PLANT MAINTENANCE	NONE *No adjustment*	CORRECTIVE MAINTENANCE ONLY *Maintenance – 25%*	ALL MAINTENANCE EXCEPT MINOR PREVENTATIVE EQUIPMENT MAINTENANCE *Maintenance – 90%*
AGE AND CONDITION OF EQUIPMENT	RELATIVELY NEW AND/OR WELL–CARED FOR *No adjustment*	RELATIVELY OLD AND/OR POORLY CARED FOR *Increase maintenance +10%*	
STORM AND INFILTRATION FLOW	NO ADJUSTMENT, EXCEPT MAY INCREASE SOLIDS DISPOSAL FOR INCREASED SCREENINGS AND GRIT		
PRESENT FLOW OPERATION AT LESS THAN DESIGN FLOW	NO ADJUSTMENT, EXCEPT COMPLETELY BYPASSED UNITS MAY BE SUBTRACTED OUT		
PATTERN OF STAFFING	SMALLER NIGHT AND WEEKEND STAFF THAN ORDINARY DECREASE APPROPRIATE STAFFING PROPORTIONATELY	NIGHT STAFF 1 FOR EVERY 3 OF DAY STAFF WEEKEND STAFF 1 FOR EVERY 3 OF WEEKDAY STAFF NO ADJUSTMENT	LARGER NIGHT AND WEEKEND STAFF THAN ORDINARY INCREASE APPROPRIATE STAFFING PROPORTIONATELY

Source: Reference 18

Figure 15. Table of adjustments for local conditions.

For example, for the level of utilization presented earlier of 1,656 hours (Table 5), the factor would be 5.29 (24 hrs x 365/1,656). This means that you need about five people for each position if it is staffed continuously. However, if the weekend and night shifts can be staffed by skeleton crews, this number can be reduced. For example, with a six-person dayshift staff and only two people on the offshifts, the total staff would be fourteen people.

Factors that affect the need for shift coverage include effluent quality, public health and safety, variability of influent quality, complexity of processes, level of discharge standards, etc. Some points to consider are:

- Plant capacity
- Highly variable influent quality (strength) or a large proportion of industrial wastes
- The reliability of the electrical energy supply and the frequency of power outages
- Advanced wastewater treatment processes at the plant
- Highly specialized equipment that requires close attention and a lot of maintenance
- Effluent discharge to highly sensitive water bodies such as just upstream from a raw water intake or into a primary contact recreational lake or stream
- The amount of remote monitoring and automation at the plant
- Effluent making up more than 50 percent of the receiving water flow
- Providing shift coverage without increasing the number of personnel (usually requires a staff of about 20 people)

After considering all these points carefully, you should use your own judgment on whether or not full shift coverage is warranted. Automatic monitoring and controls with remote alarms may be used to minimize plant staffing requirements. For example, an alarm system at the local police station may be used to signal equipment failure. The police can then contact an operator by phone.

DETERMINING THE QUALIFICATIONS AND SKILLS NEEDED

Determining the qualifications for your staff is based on common sense and judgment. However, there are some basic guidelines that may make the selection easier. The first is that nobody should have direct supervision of more than five people, which in turn requires that you develop an organizational chart. A typical chart which can be adapted for any plant is shown on Figure 16. For plants less than 10 mgd, two organizational structures are shown on Figure 17. To assist you, a list of 21 job titles and brief descriptions are included here. These are from a U.S. EPA report (19), which should be reviewed for more detailed information about each position.

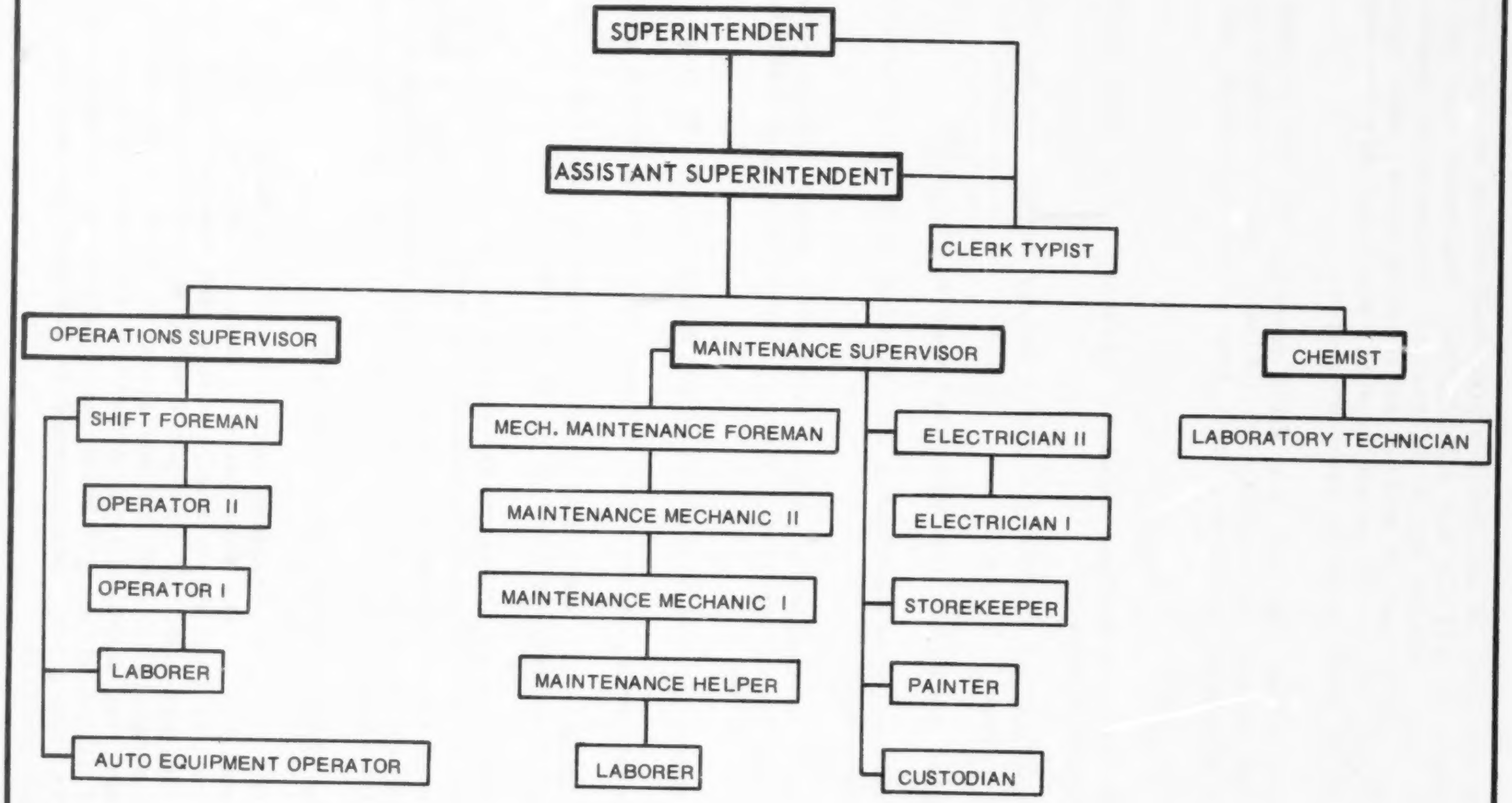
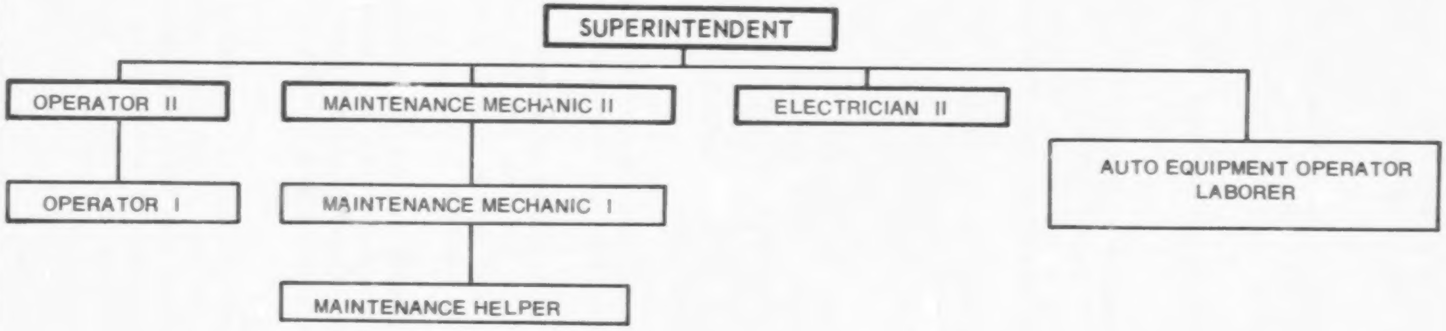
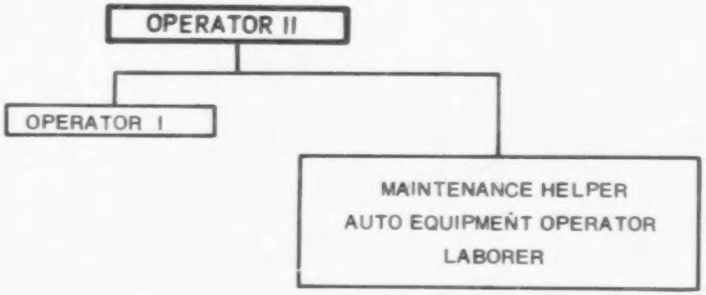

SUPERINTENDENT
ASSISTANT SUPERINTENDENT
CLERK TYPIST
OPERATIONS SUPERVISOR
SHIFT FOREMAN
OPERATOR II
OPERATOR I
LABORER
AUTO EQUIPMENT OPERATOR
MAINTENANCE SUPERVISOR
MECH. MAINTENANCE FOREMAN
MAINTENANCE MECHANIC II
MAINTENANCE MECHANIC I
MAINTENANCE HELPER
LABORER
ELECTRICIAN II
ELECTRICIAN I
STOREKEEPER
PAINTER
CUSTODIAN
CHEMIST
LABORATORY TECHNICIAN

Figure 16. Organization chart - conventional wastewater treatment plant.


SUPERINTENDENT
OPERATOR II
OPERATOR I
MAINTENANCE MECHANIC II
MAINTENANCE MECHANIC I
MAINTENANCE HELPER
ELECTRICIAN II
AUTO EQUIPMENT OPERATOR
LABORER

ALTERNATIVE 1


OPERATOR II
OPERATOR I
MAINTENANCE HELPER
AUTO EQUIPMENT OPERATOR
LABORER

ALTERNATIVE 2

Figure 17. Organizational charts - plant size: 10 mgd or less.

- Superintendent - Responsible for administration, operation and maintenance of entire plant and review of operation and maintenance functions. Exercises direct authority over all plant functions and personnel. Organizes and directs activities of plant personnel, including training programs.

- Assistant Superintendent - Assist superintendent in review of operation and maintenance functions and planning special operation and maintenance tasks and alterations.

- Clerk Typist - Clerical duties such as typing operational reports and filing, and other routine clerical duties.

- Operations Supervisor - Supervises and coordinates activities of plant operators, laborers, custodians, and other plant personnel. Prepares work schedules subject to the superintendent's approval. Inspects plant to determine efficiency of operation and maintenance requirements.

- Shift Foreman - Supervises operation of plant, under general direction of supervisors. Performs duties of operations or maintenance supervisors in their absence. Replaces operation or maintenance worker during emergency.

- Operator II - Operates treatment facilities to control flow and processing of wastewater, sludge and effluent. Observes variations in plant monitoring equipment and makes necessary adjustments. Takes samples and performs routine laboratory tests and analyses. Performs routine maintenance functions and custodial duties. Operates and maintains power generating equipment and incinerators.

- Operator I - Assists Operator II in performing the operation and maintenance duties as outlined or shall perform tasks as requested.

- Automotive Equipment Operator - Operates automotive equipment such as trucks, tractors, or fork lifts. Assists in loading and unloading of equipment. Operates equipment to cut grass and weeds, bulldoze soil, or remove snow. Performs maintenance on the equipment.

- Maintenance Supervisor - Supervises all preventive and corrective maintenance on entire plant. Plans, schedules, and directs all maintenance work. Supervises and instructs maintenance workers. Supervises inspections of contract maintenance and submits maintenance budget requests. Responsible for maintenance records.

- Mechanical Maintenance Foreman - Supervises mechanical maintenance crew in performance of maintenance repair tasks on machinery, equipment, buildings, structures and grounds. Supervises and instructs maintenance personnel on routine and emergency tasks. Consults supervisors regarding preventive maintenance program. Establishes and operates preventive maintenance program. Performs inspections and determines repair methods. Works with contractors and manufacturer's representatives on difficult tasks. Maintains maintenance records.

- Maintenance Mechanic II - Performs preventive and corrective maintenance on mechanical and electromechanical machinery and equipment, under direction of superior. Assists in keeping maintenance records and installs and sets up new equipment. Supervises, instructs, and inspects work of Mechanic I, Maintenance Helper, or Laborer to ensure proper performance of maintenance work or repairs.

- Maintenance Mechanic I - Under the direction of Mechanic II, Foreman, or Supervisor, performs or assists in performance of preventive and corrective maintenance. These tasks may also include limited laborer and custodial duties. Also, assists in keeping maintenance records.

- Electrician II - Performs corrective and preventive maintenance on electrical or electronic operating and control systems. Performs tasks using independent judgment in solving problems or under general supervision of maintenance supervisor or assistance superintendent. Maintains maintenance records and supervises Electrician I, Maintenance Helper, and/or Laborer.

- Electrician I - Assists Electrician II or performs corrective and preventive maintenance on electrical systems, fixtures, or equipment. Performs tasks based upon oral and written instructions including specifications, codes and wiring diagrams. The work is frequently performed independently and inspected by supervisor. Maintains maintenance records and supervises Maintenance Helper and/or Laborer.

- Maintenance Helper - Assists maintenance mechanic in maintaining and repairing equipment, machinery, buildings and grounds. Duties also may include maintaining simple maintenance records and performing laborer tasks as required.

- Laborer - Performs general tasks such as cleaning equipment, maintaining buildings and grounds, performing custodial tasks and carries or holds material, supplies, or tools to assist operating and/or maintenance personnel.

- Painter - Prepares surfaces for painting such as scraping, washing, burning, sanding, sandblasting, puttying and caulking. Matches, mixes, and blends various interior or exterior paints or wall covers and applies them. Erects and uses ladders, scaffolding, and swinging stage equipment. Performs simple sign painting, using stencils. Requisitions material and equipment. Responsible to maintain, clean, and store tools and equipment; and clean or have arrangements made for laborer to clean the work site.

- Storekeeper - Requisitions, receives, inspects, verifies, stores, and issues materials, supplies, tools, and equipment. Maintains inventory records; controls material; and reports materials used, spoilage or other losses, inventory adjustments, and refusal of shipment. Responsible for determining method of storage, identification and location of stock. Divides stock quantities into portions to fill orders and identifies when reorder is required.

- Custodian - Cleans all or designated portions of wastewater treatment plant and grounds. Performs general custodial duties such as cleaning restrooms, maintaining supplies, emptying waste cans and ashtrays, maintaining grounds, picking up litter, sweeping walks, and shoveling snow or cutting grass. Reports any repairs or adjustments required.

- Chemist - Supervises and performs specialized and complex chemical, bacteriological, and physical tests and analysis of wastewater and sludge samples. Assembles data, maintains records and prepares reports.

- Laboratory Technician - Assists chemist in above tasks. In absence of chemist, operates laboratory.

Using these summary descriptions, and considering the type of process and equipment at the plant, the number and qualifications of staff can be estimated for your plant. A form, shown on Figure 18 can be used as an aid to determine the number of people and skill levels. Appendix B contains some examples which show how to use this form with published staffing guidelines. Reference 15 also has an example of how to apply it.

CERTIFICATION PROGRAMS

A 1975 survey of the operator certification requirements in the U.S. showed that about 80 percent of the states have mandatory requirements for certification (21). They usually apply only to the superintendent or chief operator, however, some states require that the shift foreman or person in charge of day-to-day operation also be certified.

The certification requirements are set by each state. They generally take the form of a written and/or oral examination. In most states wastewater treatment plants are classified depending on the complexity of treatment, population served, downstream watercourse conditions, and potential health hazards. Operator qualification requirements for the four plant classifications might be like these (22):

Class I - Grammar school education or equivalent, one year experience and a passing grade in a written examination.

Class II - Grammar school education or equivalent, three years' experience and a passing grade in a written examination.

Class III - High school education or equivalent, five years' experience and a passing grade in a written examination.

Class IV - Class III certificate, two years in responsible charge of a Class III or Class IV wastewater treatment works and a passing grade in a written examination.

In some instances, there are other limitations (such as the minimum length of time you have been operating wastewater treatment plants) before you can get Class IV certification. Also, some states include a fifth wastewater treatment

ESTIMATED PLANT STAFFING COMPLEMENT

Project ____________________ Computed by ______________ Date ___________

Staff Position	Estimated Annual Payroll Requirements		Suggested Staffing
	Man hours	Number of employees*	Number of employees
Administration & General:			
Superintendent			____
Assistant Superintendent			____
Clerk Typist			____
Storekeeper			____
Subtotal	____	____	
Operation Labor:			
Operations Supervisor			____
Shift Foreman			____
Operator II			____
Operator I			____
Automotive Equipment Operator			____
Subtotal	____	____	
Maintenance Labor:			
Maintenance Supervisor			____
Mechanical Maintenance Foreman			____
Maintenance Mechanic II			____
Maintenance Mechanic I			____
Electrician II			____
Electrician I			____
Painter			____
Maintenance Helper			____
Subtotal	____	____	
Laboratory:			
Chemist			____
Laboratory Technician			____
Subtotal	____	____	
Site Work:			
Laborer			____
Custodian			____
Subtotal	____	____	
Total Labor Requirements	____	____	____

*Man hours divided by level of utilization

Figure 18. Form for estimating plant staffing positions.

plant classification. You should determine the classification of your wastewater treatment plant and make sure that all certification requirements are met. Usually, the higher and more complex the level of treatment, the higher the classification level and operator certification requirement. The plant classification level may be part of the NPDES discharge permit.

The states having mandatory or voluntary certification requirements are shown on Figure 19. Table 6 shows the certification program administration and agency in charge of the program for wastewater treatment facilities. This should be used carefully because, of those states reporting voluntary certification programs, two have been re-evaluating their programs and are tending towards mandatory certification.

Certification of plant operators does provide benefits to everyone associated with wastewater treatment programs. Whether or not certification is required for a position at your plant, you should encourage your staff to be certified. The benefits which you should describe to them are:

State Agencies

Certification gives the responsible state agency the chance to set minimum standards for the staff at all wastewater treatment facilities. Operation by a qualified operator can reduce the chance of public health hazards and nuisance. Many states have passed laws that require monthly reports from plants; a certified operator is more likely to be capable of understanding and completing these reports. Many states have noticed improvement in plant operation after mandatory certification was started, which has resulted in less operational assistance requests of the state agency.

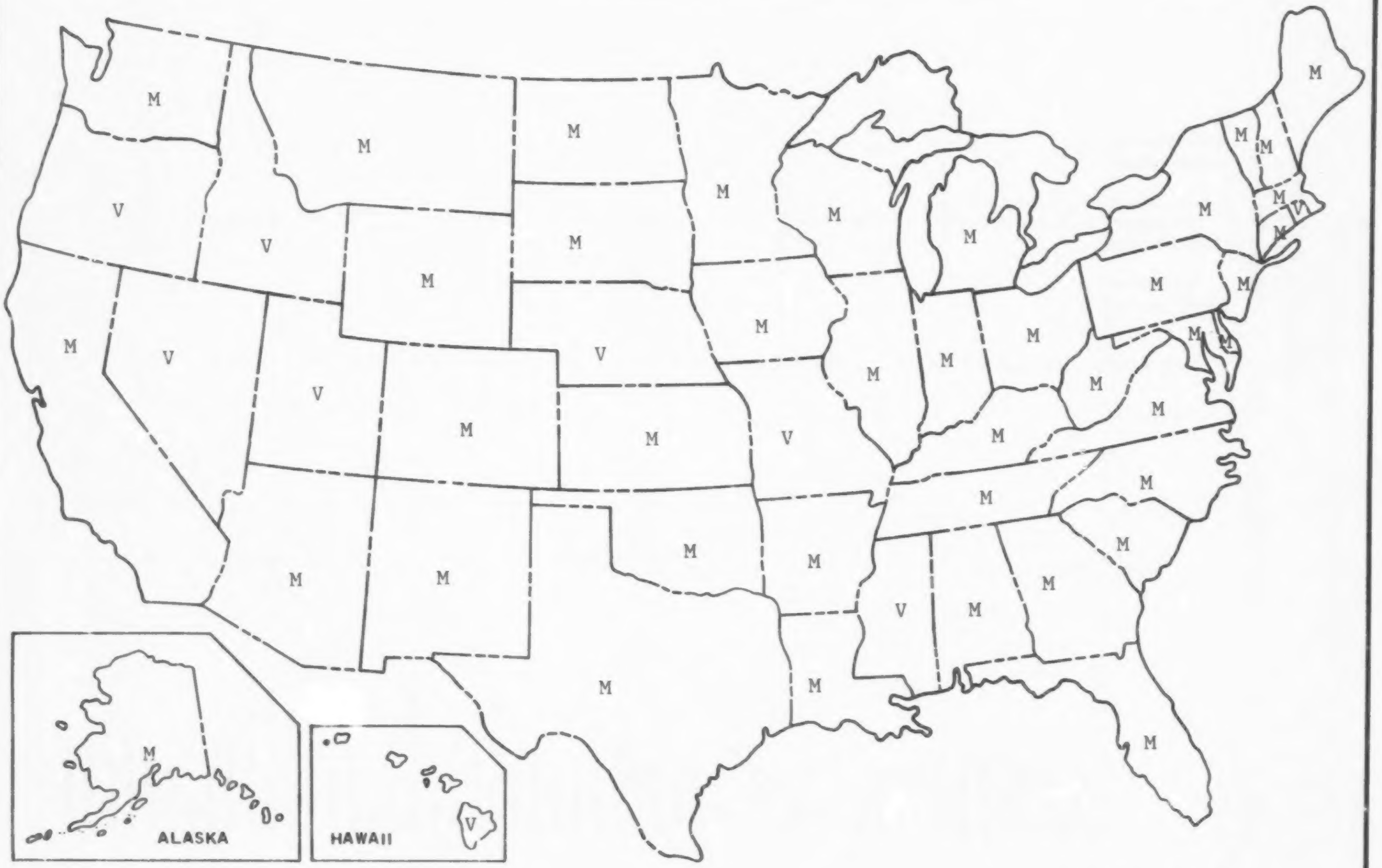
Plant Owner

The major benefit realized by the owner is the protection of the capital investment, which results in longer facility life, reduced corrective maintenance requirements, and lower operating costs. The qualified (certified) operator is more likely to understand the benefits of preventive maintenance, which can extend the life of all equipment. He will also be more aware of the laws and violation penalties.

There are indirect benefits to the owner such as improved quality of the receiving stream, protection of water supplies, and general improvement of the aquatic environment. Finally, the owner has a group of qualified people to choose from for other positions.

Plant Employees

Employee benefits resulting from certification include a recognized level of skill and knowledge, better defined professional status and responsibility, job security, and established career service. These benefits have been reported in those states that have mandatory certification requirements as well as by operators obtaining certification on a voluntary basis.


ALASKA
HAWAII

M = Mandatory
V = Voluntary

Figure 19. Certification requirements.

TABLE 6. CERTIFICATION PROGRAM ADMINISTRATION

State	Administration		Wastewater programs				
			Type		Certification administered by		
	Joint W & WW	Separte W & WW	Voluntary	Mandatory	State Agency Directly	Certification Board or Committee	WPCF Member Association
Alabama	X			X		X	
Alaska	X			X		X	X
Arizona	X			X		X	
Arkansas		X		X		X	
California		X		X		X	
Colorado	X			X		X	
Connecticut		X		X		X	
Delaware		X		X		Inactive; to be revised	
Florida	X			X	X		
Georgia	X			X		X	
Hawaii		X	X				X
Idaho	X		X			X	
Illinois		X		X		X	
Indiana	X			X		X	
Iowa	X			X		X	
Kansas		X		X	(In Transition)		X
Kentucky	X			X		X	
Louisiana	X			X		X	
Maine		X		X		X	
Maryland	X			X		X	
Massachusetts		X		X		X	
Michigan		X		X		X	
Michigan		Industry		X		X	
Minnesota	X			X		X	
Mississippi	X		X			X	
Missouri	X		X			X	
Montana	X			X		X	
Nebraska		X	X				X
Nevada		X	X				X
New Hampshire		X		X		X	
New Jersey	X			X		X	
New Mexico	X			X		X	
New York		X		X	X		
North Carolina		X		X		X	
North Dakota	X			X		X	
Ohio	X			X		X	
Oklahoma	X			X		X	
Oregon		X	X				X
Pennsylvania	X			X		X	
Rhode Island		X	X				X
South Carolina	X			X		X	
South Dakota	X			X		X	
Tennessee	X			X		X	
Texas	X			X		X	
Utah	X		X			X	
Vermont		X		X	X		
Virginia	X			X		X	
Washington		X		X		X	
West Virginia	X			X	X		
Wisconsin		X		X		X	
Wyoming	X			X			X

TRAINING PROGRAMS

There are many reasons for training wastewater treatment plant personnel. They include investment protection, efficient plant operation and maintenance, and promoting a good self-image. Today's treatment facilities are more complex and difficult to operate than the majority of the treatment plants constructed prior to passage of PL 92-500. The more complex plants require more skilled operators to meet discharge standards. The importance of training operators has been analyzed (23) in terms of the amount spent on training programs for those plants meeting and not meeting the design BOD removal criteria. The results of this analysis, shown on Figures 20 and 21, indicate a direct relationship between the amount spent on training and the number of treatment plants meeting the criteria. The analysis shows that "the average training expenditure was in every case higher at the facilities operating at or above the design level for BOD removal." Other results of this analysis were that the training expenditures at small plants with satisfactory treatment performance were twice those where design removal efficiencies were not reached, and that the average treatment plant performance improved by about 24 percent when the plant was operated by satisfactorily trained personnel. The training cost as a percentage of salary budget will vary significantly with the size of the plant and the skills and abilities of the operators.

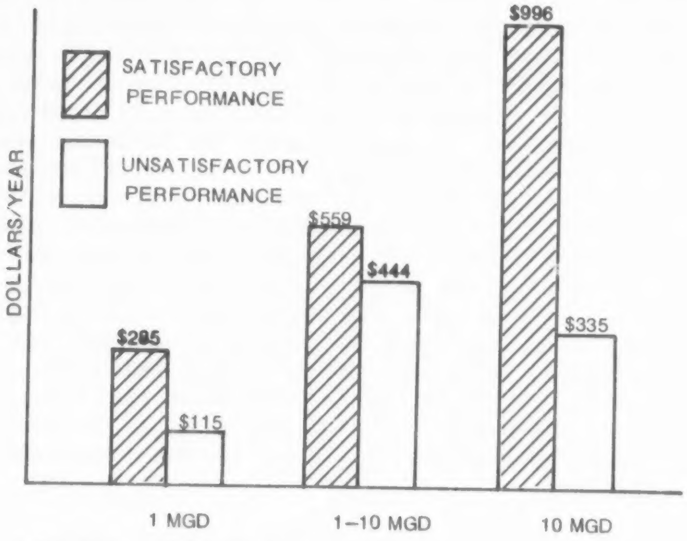
There are other benefits from proper training of plant personnel. These include avoiding damage to expensive machinery, the ability to troubleshoot a plant and the ability to fine tune a plant for good treatment at minimum cost. There are three types of training:

- Preparatory training involves training a new recruit entering the wastewater treatment profession. The training might take the form of a two-year course at an accredited community college or vocational school. The course should provide the fundamentals of wastewater treatment technology. Preparatory training may also be useful for experienced operators wishing to improve their positions by promotion or transfer to other plants.

- Skill maintenance training is the training needed to help plant operators maintain skills necessary to perform their work. This might take the form of on-the-job training sessions or short courses at local or nearby community colleges.

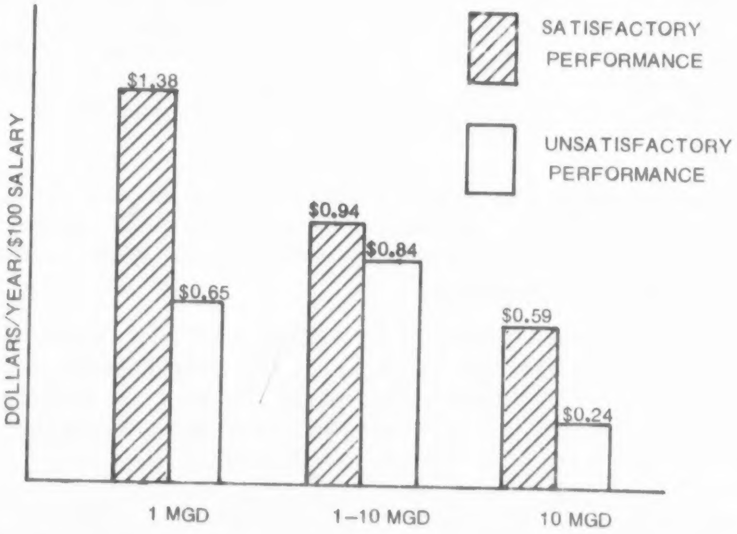
- Skill improvement training is similar to the first training program except it would involve short courses, correspondence courses, and on-the-job training. This program might be used to teach existing personnel how to operate a treatment facility that is being expanded, or to operate a particular piece of equipment.

The methods, aids, and personnel used for operator training are very important. A recent study for the EPA evaluated the problems being experienced at many wastewater treatment plants (24). The plants were evaluated in detail and items most commonly limiting the performance of each plant were determined and ranked. The top ten items are given here in Table 7. The first four are related to plant operation. The study showed that in many instances the problem was caused by



Source: Reference 23

Figure 20. Average annual training expenditures.



Source: Reference 23

Figure 21. Average annual training expenditure per $100 salary cost.

improper guidance or training. In nearly all facilities surveyed existing personnel had the aptitude to learn how to achieve better plant performance.

TABLE 7. RANKING OF FACTORS LIMITING PERFORMANCE FOR THIRTY EVALUATED FACILITIES

Item no.	Ranking (total points)	Factor	No. of times cause occurred	No. of times cause ranked #1	Total points
1	1	Operator Application of Concepts and Testing to Process Control	28	6	53
2	2	Sewage Treatment Understanding	20	4	42
3	3	Technical Guidance	17	5	37
4	4	Process Control Testing	21	0	34
5	5	Sludge Wasting Capability	18	3	33
6	6	Process Flexibility	16	2	32
7	7	Process Controllability	20	0	31
8	8	Clarifier (Secondary)	11	2	21
9	9	Sludge Treatment	15	0	19
10	9	Aerator	9	2	19

On-The-Job-Training

On-the-job training can be a formal classroom approach or through individual instruction as part of a normal daily routine. The classroom approach should be arranged at the end of one shift and the beginning of the next shift in order to have as many people as possible attending the class.

The principal reasons for training and, more particularly, for on-the-job training include:

- To transfer ideas from the design engineer to the plant staff
- To provide information on specific unit processes used at the plant
- To show methods for optimizing the efficiency of unit processes using the actual treatment units involved
- To provide "hands-on" training with feedback at a full scale, operating facility
- To use the classroom and "hands-on" approach to minimize trial-and-error plant operation
- To increase operator confidence by giving "hands-on" experience in the presence of the instructor

Miscellaneous Training Courses

There are several other methods available for training wastewater treatment plant operators. These include short schools; correspondence courses; college extension classes; and classes at community colleges, vocational schools, and special schools offered by many state agencies. Many of the schools offer continuing education units for their courses. A certain number of these units may be required for certification renewal in your state. These alternates are briefly discussed below.

- Short Schools - Offered by state pollution control agencies or universities, short schools are usually held once per year. They are usually classroom-type courses taught by experienced, certified operators who may also have college degrees. You should check with the local state regulatory agency or local Water Pollution Control Association to find out about the courses held in your area.

- Correspondence Courses - Correspondence courses are completed by mail. The type of course allows self-pacing and the chance for the student to test the course material at his facilities. The student must work alone, without personal contact from an instructor. Correspondence courses include those offered by the Water Pollution Control Federation, California State University of Sacramento, and International Correspondence School.

- College Extension Courses - These courses are similar to the short schools, but are offered by the extension division of local universities. The extension classes are frequently geared to more specialized skills and can be taken for college credit.

- Community Colleges - The community colleges or two-year schools that serve your area may offer a complete two-year associate degree in wastewater treatment plant operation. These courses provide ideal training for those people starting a career in the wastewater treatment field. Part-time or evening courses are also suitable for the fully employed operator. You should contact the local community college for more information about these classes.

- Vocational Schools - One- or two-day schools or seminars are often held throughout each state. These schools are put on by state agencies as well as by the EPA and private consultants. You can get the school schedules from your state pollution control agency. In some instances, you can arrange to hold these special schools at your plant.

- Local Association Schools - The local Water Pollution Control Association and other such organizations hold schools for operator training. Information on times and locations can be obtained from the magazines or bulletins published by the local association or from the Association secretary.

Selecting a Training Approach

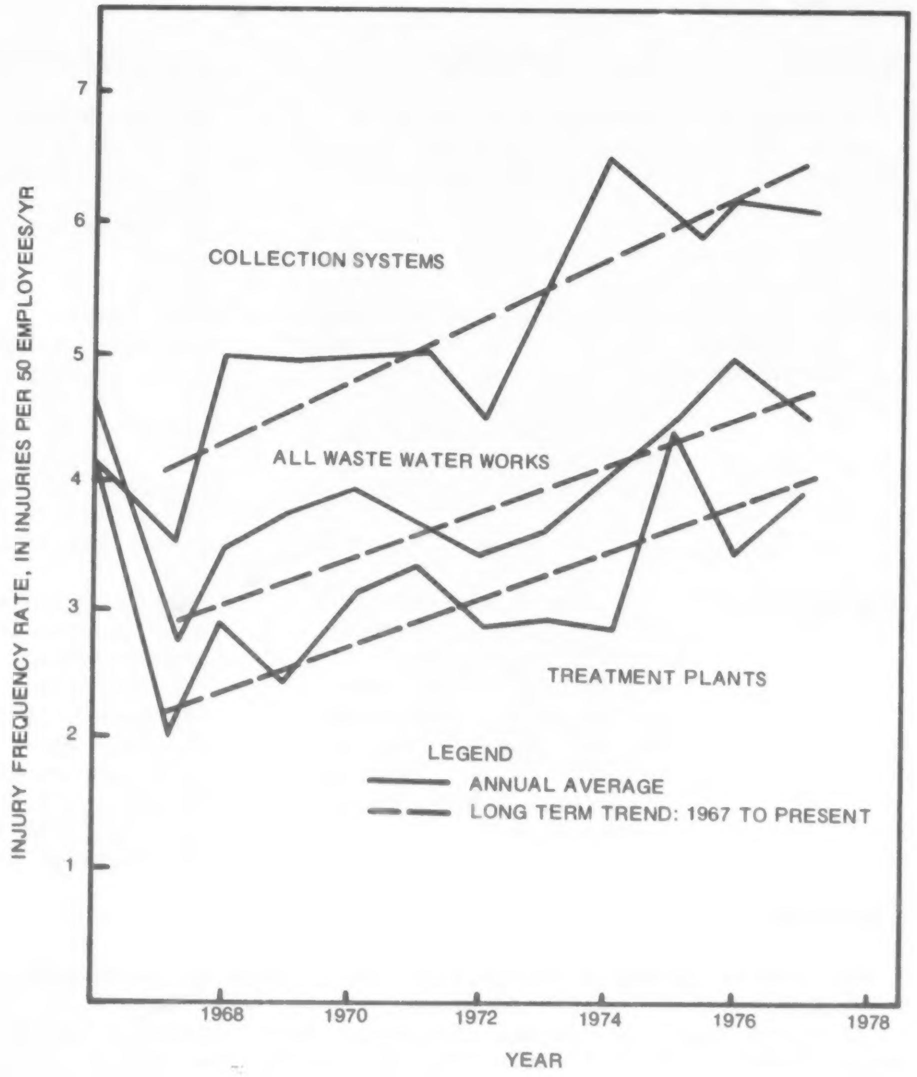
There are several factors to consider in deciding which training approach to use. You must compare the advantages and disadvantages of each approach. Some are listed below (25):

Type of Course	Advantages	Disadvantages
On-the-job training by the use of the demonstration approach.	Learning in a practical situation, trainee can see and hear the operation.	May be one-way communication, difficult to set up, may place heavy demands on instructor, limited number of trainees can participate.
Self-instruction by correspondence course or other educational packages.	Cost/man hour is usually low, trainees are actively involved, instruction is self-paced and consistent, and materials have been pre-tested and their effectiveness proven.	Slow feedback, no instructor for supplemental guidance, requires high level of motivation, and can be difficult to teach "hands-on" experience because specific self-instructional materials are not always available.
Classroom approach.	Less time-consuming, more material can be covered quickly, fewer interruptions allow instructor to pursue objectives, and the same lecture can be given to more than one group with little in-between preparation.	Communication may be one-way, opportunities for misunderstanding information are great, and lectures cannot be tailored to individual needs and may lack trainee involvement. Planning a lecture that will hold the interest of the trainees is difficult.

SAFETY PROGRAMS

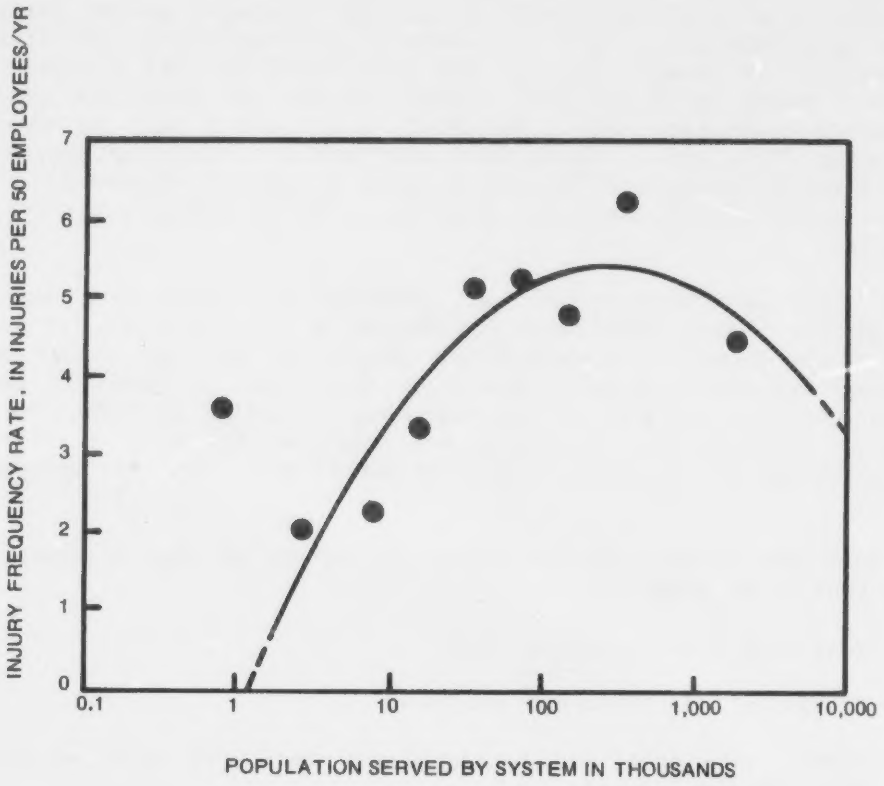
A WPCF Safety Survey taken in 1978 (26), shows an increasing trend in the injury frequency at wastewater treatment plants, as can be seen in Figure 22. Figure 23 shows that the injury frequency rate increases sharply until the population served is about 250,000. The decline for the larger plants may be due to having a full-time safety officer at the plant. This information points out the need to pay more attention to safety in the small- to medium-sized municipal wastewater treatment plants. The following suggestions on how to set up a safety program and the benefits to be derived from them may be helpful to you in assessing your safety needs.

A good safety program at a wastewater treatment facility can reduce the frequency and seriousness of accidents. A successful safety program must start with management; it is up to you to start and follow the program. A good program will accomplish three goals: reduce the total cost of operations, increase



Source: Reference 25

Figure 22. Injury frequency rate vs. year.



Source: Reference 25

Figure 23. Injury frequency rate vs. population served by system.

productivity (the level of utilization), and provide a feeling of security and well-being for plant personnel. Safety is the common sense approach to any task, but the real key to safety is the individual worker (13).

At the start of the program, you should explain it completely, name a person to be in charge of it, describe the advantages of it, and finally, spell out the responsibilities of each individual. At smaller treatment plants, you may be the supervisor and, therefore, have the complete responsibility for directing the safety program. You should encourage the plant staff to take a course in safety and first aid taught by a qualified safety engineer and first aid instructor. An outside safety consultant should be hired about once a year to check on your safety program. This person should also make periodic checks of operational procedures and report any safety hazards or areas in need of improvement. The safety engineer or technician should also establish a set of safety rules for each part of the plant.

After the safety program has been prepared you should have regular safety meetings at the plant. These meetings should be held monthly, or more often, depending on the potential hazards at the plant. The meetings should be 10 to 30 minutes long and the employees should be encouraged to actively participate. You should have the meetings at the beginning or end of a shift, but always on paid time to indicate the importance you place on the program. Films on safe driving, slips and falls, gases, danger of fires, etc., are very helpful instructional aids.

You have the primary responsibility for safety at your treatment facility. It covers four major areas (27):

- Providing a safe place to work
- Providing safe equipment and tools
- Hiring only qualified personnel, or personnel with an interest and aptitude for learning
- Training workers for job skills as well as safety precautions

Some safety features of the plant that must be maintained are:

- A minimum of two employees should be assigned for any work that is potentially dangerous such as manhole inspections, machinery maintenance, etc.
- Handrails should be provided around all basins and openings.
- All stairs, walkways, and platforms should be free of grease, oil, and debris, and well lighted.
- Adequate ventilation systems should be provided for all enclosed spaces.
- Life preservers and throwlines should be provided adjacent to all basins, ponds, and lagoons.

- Protective guards should be provided on all rotating machinery.
- Protective guards and handrails which can be removed for maintenance should be replaced after maintenance work is complete.
- Where flammable gases may be present, explosion-proof electrical equipment should be provided and all bolts, gaskets, globes and guards should be intact.
- Carbon dioxide fire extinguishers should be provided adjacent to motor control centers and automatic control systems.
- Signs should be provided at the entrance of all wet wells and rooms in which toxic or flammable gases may be present.
- Instrumentation for the detection of toxic and flammable gases and low oxygen levels should be provided and should be operational.
- All boats at lagoons should be provided with a life jacket for each person.
- All vehicles should be equipped with appropriate safety equipment, including lights, horns, windshield washers, and fire extinguishers.
- Pressure vessels should be operated within their design rating and should have a pressure relief valve.
- Ear muffs should be provided at the entrances of all rooms that are excessively noisy.

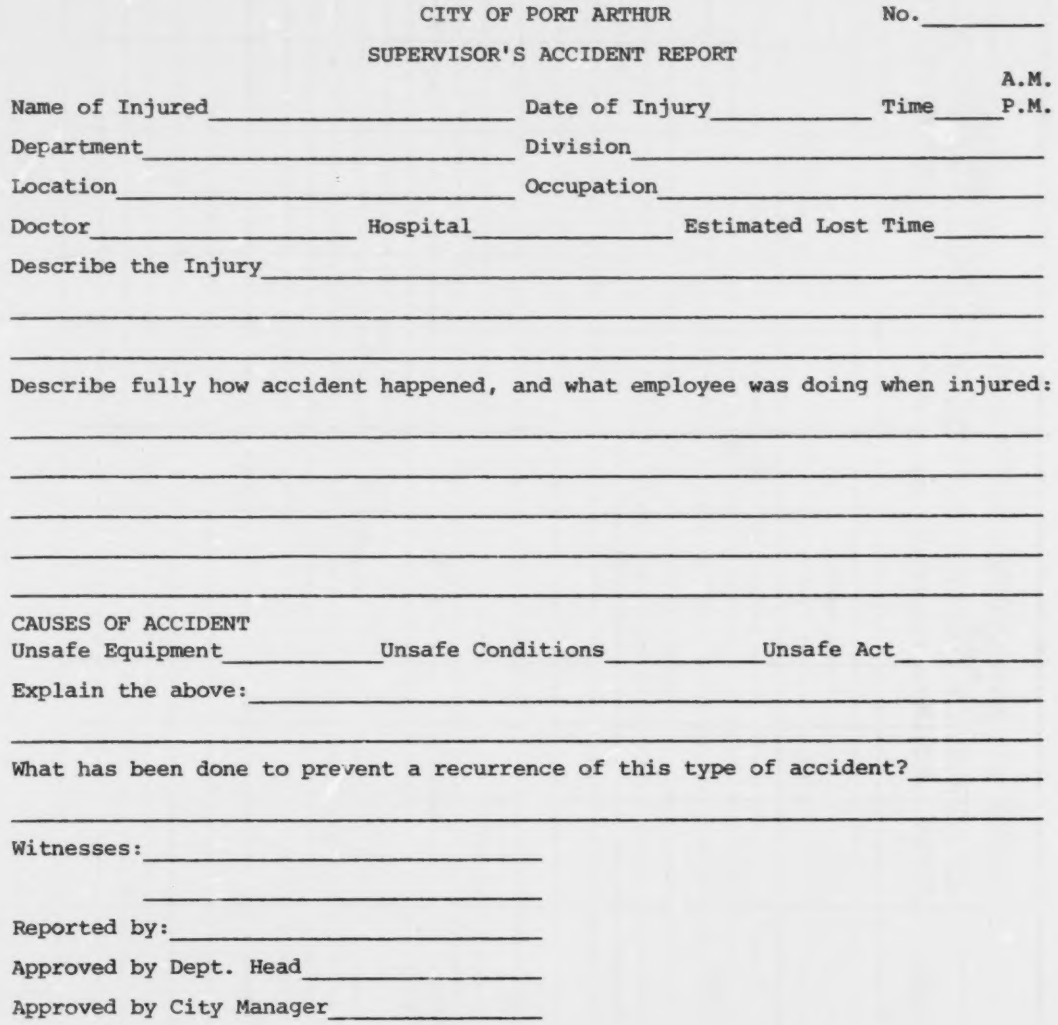
A list of minimum recommended safety equipment is given in Table 8.

After a new employee has been hired, you must be sure that he is given the proper training in both the work skill for the position and in the safety program. This will greatly reduce the chance of accidents.

In case of accident, the immediate supervisor and safety officer should be informed. The supevisor should investigate each accident thoroughly and complete an accident report similar to the one shown on Figure 24. In the event an employee needs medical attention, he should be taken to a specified doctor, clinic, or hospital. The accident report should show the doctor's name and diagnosis, the cause of the accident, and what has been done to prevent it from happening again. The information on these forms can be used to prepare a monthly summary of all accidents. A form such as the one shown on Figure 25 can be used. You should review these reports to find ways of decreasing accidents.

TABLE 8. MINIMUM RECOMMENDED SAFETY EQUIPMENT FOR WASTEWATER WORKS PERSONNEL

Equipment	Use
Portable air blower (gas motor or electric motor operated)	Ventilating manholes and other enclosed subterraneous structures
Electric explosion-proof lantern	Illumination in tanks or sewers where gas may be present
Safety harness	For workers entering deep manholes or tanks
Hose mask with hand blower and 50-ft hose	Respiratory protection in all gas and vapor atmospheres including oxygen deficiency
Two self-contained air packs for plants using chlorine	Respiratory protection against chlorine gas leaks



CITY OF PORT ARTHUR No.________

SUPERVISOR'S ACCIDENT REPORT

Name of Injured________________ Date of Injury__________ Time____ A.M. P.M.

Department________________ Division________________

Location________________ Occupation________________

Doctor__________ Hospital__________ Estimated Lost Time______

Describe the Injury________________________________

Describe fully how accident happened, and what employee was doing when injured:

CAUSES OF ACCIDENT

Unsafe Equipment________Unsafe Conditions________Unsafe Act________

Explain the above:________________________________

What has been done to prevent a recurrence of this type of accident?________

Witnesses:________________

Reported by:________________

Approved by Dept. Head________________

Approved by City Manager________________

Source: Reference 13

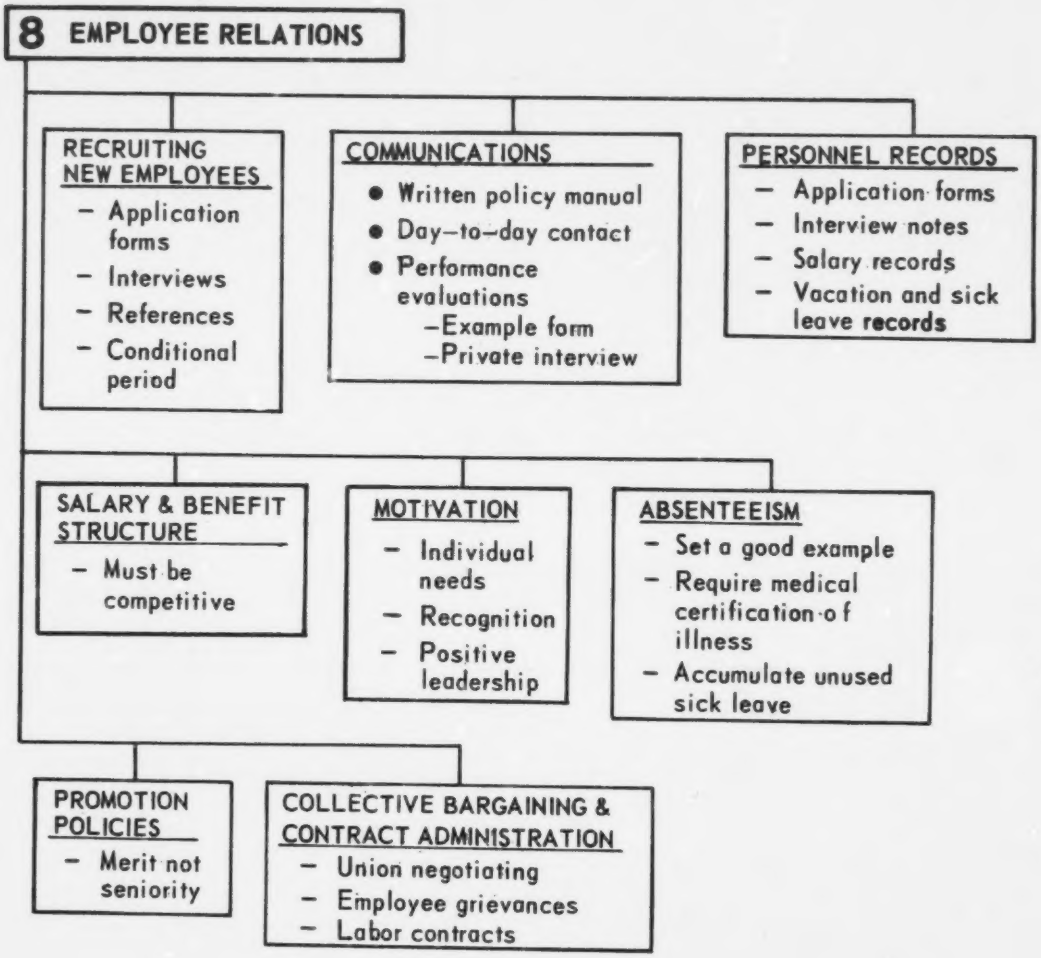
Figure 24. Supervisor's accident report form.

CITY OF PORT ARTHUR MONTHLY ACCIDENT SUMMARY

	THIS MONTH						CUMULATIVE THIS YEAR					
Department & Divisions	Man Hrs Worked	Minor Acc.	L.T. Acc.	Days Lost	Fre-quency	Sever-ity	Man Hrs Worked	Minor Acc.	L.T. Acc.	Days Lost	Fre-quency	Sever-ity
General Government:												
City Manager												
City Secretary												
City Attorney												
Finance												
Tax												
Personnel												
Inspection & Permits												
Public Safety:												
Police												
Fire												
Civil Defense												
Health:												
Electrical:												
Public Works:												
Engineering												
Street Maintenance												
Street Construction												
Urban Renewal												
Drainage												
Bridge												
Sanitation												
Administration												
Parks & Recreation:												
Library:												
Water & Sewer:												
Water Office												
Water												
Sewer												
TOTALS												

Source: Reference 13

Figure 25. Monthly accident summary form.


8 EMPLOYEE RELATIONS
RECRUITING NEW EMPLOYEES
– Application forms
– Interviews
– References
– Conditional period
COMMUNICATIONS
● Written policy manual
● Day–to–day contact
● Performance evaluations
–Example form
–Private interview
PERSONNEL RECORDS
– Application forms
– Interview notes
– Salary records
– Vacation and sick leave records
SALARY & BENEFIT STRUCTURE
– Must be competitive
MOTIVATION
– Individual needs
– Recognition
– Positive leadership
ABSENTEEISM
– Set a good example
– Require medical certification of illness
– Accumulate unused sick leave
PROMOTION POLICIES
– Merit not seniority
COLLECTIVE BARGAINING & CONTRACT ADMINISTRATION
– Union negotiating
– Employee grievances
– Labor contracts

SECTION 8
EMPLOYEE RELATIONS

RECRUITING NEW EMPLOYEES

Staffing a plant with well-trained employees with high morale and a desire to do a good job will get the most out of your plant (18).

Good recruitment and selection of employees is a key to successful operation and maintenance. You must remember that sewage treatment plant employment is not attractive to most people unless there is no other source of similar employment or the salaries being offered are comparatively high. A survey (29) found that in half of the wastewater treatment plants studied, it was difficult to recruit people. Notices and advertisements announcing the job openings should stress positive aspects such as the technical challenges, the chance for training and advancement, fringe benefits, the steady nature of the work, and salaries. Good salaries are a key, of course, in attracting personnel. Poor salaries make recruiting good personnel difficult.

In planning and implementing a recruitment program, you must consider the requirements of affirmative action hiring. If you do not have an affirmative action program, you should look into developing and implementing one. The first step is to examine your recruitment and hiring policies to see how they might be changed if they are not in compliance with the Equal Employment Opportunity Commission (EEOC) guidelines. You should then adopt measures to make up for past weakness and promote equitable hiring practices. Remember, however, it is crucial that your staff be properly qualified for the jobs they hold. Underqualification or overqualification can present serious operating problems.

The first step in hiring is to have the applicant fill out an application form. Your community may already have developed a form which you can use with little change. It should include a work history, references, and educational summary. You must recognize that some applicants will exaggerate their qualifications. The application form should state that false statements are grounds for discharge. When this warning is printed on application blanks, it tends to minimize such statements; it also provides a sound basis for discharge.

Applicants typically give people who are especially friendly to them as references. You should talk with an applicant's former employers and also with his references in person or by telephone. These persons will be more frank and honest in a confidential personal conversation than they will in general letters of reference. Many bad personnel selections have been made by accepting the statements on applications, in reference letters, and in interviews at face value.

The best of the applicants are usually interviewed. Interviews offer some hazards because of possible prejudice on the part of the interviewer, whether it be the color of the skin, the sex of the person, the way he looks or talks, or something else.

One method of selecting employees is the use of an examination on basic mathematics, mechanical aptitude, and general intelligence coupled with a medical examination. Experience (30) has shown that most people recruited with this approach show good interest in their jobs. You should work with your city's civil service personnel to set up appropriate testing procedures. If you don't have a civil service department, contact a nearby city or your Water Pollution Control Association for example exams.

Even a good, honest, and complete evaluation of an applicant is no substitute for personal experience with the individual. A period of trial or probationary employment gives you the chance to measure the employee's ability. If the employee proves inadequate, he should be dismissed or assigned to a more suitable position.

In the event an employee leaves, you should have an exit interview with him. This will be useful to you in finding out why he's leaving and determine any problems he sees with his job and your management policies. It is useful for the employee since he will get a final evaluation of his performance. Every effort should be taken to see that both of you remain calm and unemotional, but frank.

COMMUNICATIONS

Employee Manual

You should have a manual for your employees which has written policies on sick leave, vacation, training, insurance, holidays, etc. The manual need not be elaborate. However, it is important to give written personnel policies to all employees.

Day-to-Day Contacts

Keep in mind the following general guidelines (31) in your day-to-day dealing with your staff:

- People need to feel significant. They need to belong; they need security and opportunity. When you help people meet these needs, you are being a good manager. It is not enough to feel these things - action must reflect attitude.
- Use praise and sincere appreciation rather than criticism.
- Know and be known by your people - let your actions honestly represent your attitudes.
- Stress advantages, not punishment and penalties.
- Learn to listen as well as to talk. If you are getting a negative reaction from your listeners, change your approach.
- Maintain self-control.

- Repeat directions and explanations until they are remembered and understood.

- Encourage employees to discuss their problems with their supervisor.

Performance Evaluations

A good evaluation of performance of each employee is important. A regular, formal review of performance can be a good communication and management tool. Many managers don't like this task, but it can be of value if properly used.

The goals of performance evaluation include: improved employee performance, motivation, and morale; employee development; better supervisor-employee communications; and good basis for assignments, promotion, merit increases, layoff, transfer, and the like. Other benefits include discovering areas in which training is needed, and finding all of the employee skills and talents. Some general points to keep in mind on performance appraisals are:

- Performance refers to what an employee has done or is doing. Don't guess about what the employee might be capable of doing or what you would like him or her to do. Performance is on-the-job behavior that can be recorded and evaluated.

- Evaluation is measuring what a person does in relationship to what he is supposed to do in his job.

- Potential is an estimate of how a person will perform in a new position. It is based on accurate records of past and present performance.

- Don't confuse performance with personality unless you can show that a personality trait, or its absence, affects performance.

- Measure what is accomplished rather than how it is accomplished. Different people achieve results in different ways, and the result is what counts. If a method is unsafe, however, it must not be permitted.

- Single out the key factors which make the difference between superior and average performance. Poor self-discipline, for example, may make a person unsuitable for certain assignments, even though he or she is good in other respects.

- Make certain that the evaluator does not let prejudices influence his judgments. This is no easy task. All people are affected by certain characteristics, mannerisms, or physical aspects of other people. By concentrating on results, prejudices will be less likely to affect the evaluation.

- Always think of performance. One-time errors or achievements will be less likely to distort long-term evaluation.

- Keep ratings private.

Many different types of forms have been developed for use in performance appraisals. Table 9 is an example form.

The following steps are involved in an effective appraisal (32).

Before you discuss the review with the employee, collect facts and make a careful appraisal. When you list areas in which the employee is weak, give specific examples. For example, if you feel he lacks initiative, be ready to point out instances where he failed to show initiative. Simply telling him he needs more initiative will be of little help to him. In making your evaluation, you should ask yourself if you have done all you can to help the employee do a good job.

The next step in preparing for the interview is to decide what you want to accomplish. Do you want to help the employee understand what his faults are and why he should correct them? Do you want to let him know how effective he is and that you are thinking of giving him added responsibility? Do you want to get him to agree with you on specific steps for his own improvement? Knowing your basic aim will enable you to organize your remarks more effectively. In planning what you're going to say, consider his personality and try to use an approach that will put him at ease.

The interview should be conducted in private. Make sure that you will not be interrupted by phone calls or visitors.

Use an informal tone and emphasize that the purpose of the interview is to help the employee help himself. Ask the employee how he is coming along on the job and what problems or obstacles he feels he has. Encouraging him to talk may help him understand his position better and it will help you understand his attitudes and outlook. Let him know you are interested in what he is saying. Here are a few pointers on being a good listener:

- Listen attentively so he feels you are eager to understand every word he says.

- Nod or say "I see" or "I get what you mean" from time to time. This will encourage him to keep on talking.

- When he has finished talking, summarize what he has said. Then give him time to make corrections or additions.

What the employee tells you may force you to make some changes in your evaluation of his performance. Some problems that you were unaware of may have affected his work. Do not launch into your appraisal without considering what you have just learned.

Discuss the employee's strong points early in the interview. Mention examples of outstanding performance that you have observed. Encourage him to keep working on his stronger characteristics.

When reviewing weak areas, discuss only weaknesses for which you can provide examples. Without examples, the employee may feel that you are being unfair.

TABLE 9. ILLUSTRATIVE PERSONNEL PERFORMANCE EVALUATION FORM

Name:____________________ Date:__________

Job Title:____________________ Date of Entry Into Present Job:____

Organization____________________

Name and title of person making performance appraisal:

____

MAJOR CATEGORIES (FROM LOW TO HIGH)

Job Knowledge: the information on work duties which an employee should know for a satisfactory job performance.

____ Poorly informed about work duties
____ Lacks knowledge of some phases of work
____ Moderately informed; can answer most common questions
____ Understands almost all phases of work
____ Has complete mastery of job

Quality of Work: doing work that meets or exceeds quality standards.

____ Usually below minimum acceptable quality
____ Often below minimum acceptable quality
____ Acceptable quality most of the time
____ Often above acceptable quality
____ High quality work consistently exceeds acceptable standards

Quantity of Work: the amount of work an individual does in a normal day.

____ Does not meet minimum requirements
____ Does just enough to get by
____ Volume of work is satisfactory
____ Very industrious; does more than is required
____ Superior work production record

Stability: the ability to withstand pressure and to remain calm in a crisis situation.

____ Goes "to pieces" under pressure; is "jumpy" and nervous
____ Occasionally "blows up" under pressure; is easily irritated
____ Has average tolerance for crises; usually remains calm
____ Tolerates most pressure; likes crises more than the average person
____ Thrives under pressure; really enjoys solving problems

TABLE 9. (Continued)

Accuracy: the correctness of work duties carried out

____ Makes many and frequent errors
____ Makes recurrent errors; is generally careless
____ Usually accurate; makes only a limited number of mistakes
____ Is exact and precise most of the time; requires little supervision
____ Is almost always accurate; requires absolute minimum of supervison

Alertness: the ability to meet changing conditions and to solve new problem situations, and to grasp instructions.

____ Slow to grasp a situation
____ Requires extensive and detailed instructions and explanations
____ Grasps instructions with average ability
____ Usually quick to understand and learn
____ Exceptionally keen and alert

Creativity: the capacity for having new ideas for finding new and better ways of doing things and for being imaginative.

____ Rarely has a new idea; unimaginative
____ Occasionally comes up with a new idea
____ Has average imagination; has reasonable number of new ideas
____ Frequently suggests new ways of doing things; is very imaginative
____ Continually seeks new and better ways of doing things

Dependability: the ability to do assigned jobs well with a minimum of direction; reliability.

____ Requires close supervision; is unreliable
____ Sometimes requires prompting
____ Usually takes care of necessary tasks and completes with reasonable promptness
____ Requires little supervision; is reliable
____ Requires absolute minimum supervision; highly reliable

Drive: the desire to attain objectives and to achieve assignments.

____ Has poorly defined goals and acts without purpose; puts forth little or not effort
____ Sets goals too low; does little to achieve
____ Has satisfactory goals and usually acts to reach them
____ Strives hard; has high desire to achieve
____ Sets high goals and strives to reach these

TABLE 9. (Continued)

Courtesy: the polite attention an individual gives to fellow workers, superiors, and to other people.

____ Discourteous and sometimes antagonistic
____ Sometimes tactless, thoughtless, or too blunt
____ Agreeable and pleasant under most situations
____ Almost always very polite and willing to help
____ Inspiring to others in being regularly courteous and pleasant in work relationships

Sociability: the friendliness and warmth which an individual imparts in his attitude toward customers, other employees, his supervisor and the persons he may supervise.

____ Distant and aloof; these qualities adversely affect work
____ Approachable; friendly once known by others
____ Warm, friendly, and sociable most of the time
____ Sociable and out-going
____ Extremely sociable; excellent at establishing good will

Personality: an individual's behavior characteristics or his personal suitability for the job.

____ Personality is unsatisfactory for this job
____ Personality is questionable for this job
____ Personality is satisfactory for this job
____ Desirable personality for this job
____ Outstanding personality for this job

Personal Appearance: the personal impression an individual makes on others. (Consider cleanliness, grooming, neatness, and appropriatness of dress, if these are relevant to this job.)

____ Very untidy or poor taste in dress
____ Sometimes untidy and careless about personal appearance
____ Generally neat and clean; satisfactory personal appearance
____ Careful about personal appearance; good taste in dress
____ Unusually well groomed; very neat; excellent taste in dress

Physical Fitness: the ability to work consistently and with only moderate fatigue. (Also consider and weigh physical alertness and energy.)

____ Tires easily; low on energy
____ Frequently tires and is slow
____ Meets physical and energy job requirements
____ Energetic; seldom tires
____ Excellent health; little fatigue; highly energetic

TABLE 9. (Continued)

Attendance: frequency and punctuality in coming to work, conforming to work hours, and not abusing sick leave.

____ Often absent without good excuse and/or frequently reports for work late
____ Lax in attendance and/or reporting for work on time
____ Usually present and on time
____ Very prompt; regular in attendance
____ Always regular and prompt; volunteers for overtime when needed; highly conscientious about attendance and punctuality

Housekeeping: the orderliness and cleanliness in which an individual keeps his work area.

____ Disorderly or untidy
____ Some tendency to be careless and untidy
____ Ordinarily keeps work area fairly neat and clean
____ Conscientious about neatness and cleanliness; above average
____ Unusually neat, clean, and orderly; outstanding

Overall Evaluation: in comparison with other employees with the same length of service on this job.

____ Definitely unsatisfactory and far below average
____ Substandard but making progress
____ Doing an average job; satisfactory performance
____ Definitely above average
____ Outstanding

SPECIFIC COMMENTS

Major points, subjects, or areas for improvement are:

1.
2.
3.
4.

These can be strengthened by doing the following:

TABLE 9. (Continued)

Major strong points are:

1.
2.
3.
4.

These can be used more effectively by doing the following:

RATED BY ____
(NAME) (DATE)

A copy of this report has been discussed with me and has been given to me.

(EMPLOYEE'S SIGNATURE)______________________________DATE______________

If the employee disagrees with this rating in any way, he will note specifically the points of difference, attach a sheet, and sign it.

Don't make unfavorable comparisons with the work of others, don't blame the employee for poor performance, and don't talk down to him.

Before you offer any suggestions for improving performance, ask the employee for his ideas. If he has none, put your suggestions in the form of a question: "Do you think you could do a better job if...?" or "Is there anything I can do to help you?" When he has agreed with you on the steps to be taken, tell him what standards you want him to meet and how you will measure achievement. Be sure he feels they are reasonable.

In ending the interview, review the points that have been made and encourage the employee to summarize them in his own words. Assure him that you are interested in his progress and tell him you are ready to talk to him at any time.

If the employee is cooperative and you have handled the interview with skill, everything should go smoothly. Occasionally, however, an employee may give you a hard time. He may be angry when he hears your appraisal of his work. At such times, do not become emotionally involved. Remain calm. Do not attempt to force him to agree with you. If he starts to argue with you, it is best to end the interview.

No matter how well you conduct the interview, you must follow through afterwards. After you have worked out an improvement plan with an employee, make a point to see how he is doing. Praise him for any progress he has made. If he still has difficulties, try another approach. Unless you follow through, employees may decide that the interviews do not mean much and they will be less cooperative the next time.

PERSONNEL RECORDS

An elaborate set of personnel records and forms is not needed, but there is certain information on each employee that should be kept as part of a permanent record:

- Original application form
- Your notes from the initial interview
- Insurance and tax forms
- Performance appraisal forms
- Salary history
- Sick leave and vacation history
- Training and/or certification achievements
- Notes from an exit interview if the employee leaves for any reason

SALARY AND BENEFIT STRUCTURE

In order to attract and retain good people, it is necesary to have a competitive salary and benefit structure. If you are part of a municipal government, the general structure may be city-wide. A separate wastewater utility has more direct control over the structure.

The WPCF conducts a national survey of salaries and fringe benefits of water pollution control facilities personnel every two years. The survey is summarized in "Deeds and Data" (33), and the full report ("Personnel Advancement Committee's Wastewater Treatment Facilities Salary and Fringe Benefits Survey") may be ordered from the WPCF. Among the fringe benefits studied in the survey are vacation time, holidays, sick leave, sick leave carryover, vacation carryover, retirement pension programs, health insurance, surgical insurance, major medical insurance, life insurance, types of working agreements (union, non-union, civil service), educational expenses, technical organization membership dues, work clothes expense, etc.

Your review of the WPCF survey will provide an estimate of competitive salaries and fringe benefits in wastewater treatment facilities similar to yours. You must also, of course, be aware of the salary and fringe benefits of local industries which may compete for the same type of personnel you seek.

Document your arguments if you find that your salary and fringe benefit structure is not competitive. This documented case should then be presented to your governing board. If an effective public relations program has resulted in an educated board and public, a well documented problem will have a better chance of being resolved. Without documentation and education, an inadequate salary structure is likely to persist and result in maintenance costs which might be higher than if salaries are competitive.

MOTIVATION

You can use your position to improve motivation of your staff. First, you must recognize the aspects of work that most people consider important. According to a U.S. Department of Labor survey (34), the eight most important factors in order of performance are:

1. Interesting work
2. Enough help and equipment to get the job done
3. Enough information to get the job done
4. Enough authority to get the job done
5. Good pay
6. Opportunity to develop special abilities
7. Job security
8. Seeing the results of one's work

Of course, each individual has his own set of needs. Status may be important to one but not to another. You should recognize the needs of each individual in deciding how to motivate him.

Many studies have shown that workers want to feel important. Remember these needs and try to meet them. People want to be treated as individuals; they want to know that they and their work are important; and may want to have more challenging work. These are important needs (35).

Motivation studies have found that higher pay usually motivates individuals for a period of time, but then it loses force without even more economic rewards. In time, economic rewards are taken for granted. Still, even if their effect is only for a short period, such incentives will continue to play a strong motivating role, for inadequate pay causes worker dissatisfaction.

As part of a public utility, you don't have much freedom to use pay raises as incentives. You must use other ways to reward workers such as certificates and letters of recommendation, testimonial dinners, or public recognition for outstanding job performance. The average individual likes recognition.

Your leadership characteristics will be a strong factor in determining the motivation of your staff. The following comparison (34) of positive and negative leadership characteristics will provide some practical guidance to you in terms of motivating your staff:

Positive Leadership Action	Negative Leadership Action
1. Consistency. The able leader is consistent in his behavior pattern. For example, he is not warm and friendly one day and cold and distant the next; a tough and then an easy disciplinarian. He knows that people like to know what behavior to expect.	1. Inconsistency. People do not know how to react when a leader varies his behavior pattern widely. If he is a firm disciplinarian on one occasion and soft on another, he will confuse his staff and cause hard feelings.
2. Friendliness. He does not overdo friendliness. Genuine friendliness means neither over-familiarly nor an attempt to win a cheap popularity. It is a sincere liking of people.	2. Aloofness. People like to have their boss act in a friendly, informal manner towards them. The manager who rarely says a friendly word is rarely liked and is often not trusted.
3. An individual approach. The good leader tailors his approach to each person on an individual basis. He knows that what works well with one person may not go over with another. He studies each individual who is assigned to him so that he knows well how he acts and reacts. For a leader to influence people in a highly successful way, he must treat each differently.	3. A standard approach to dealing with people. This approach gives little or no consideration to the differences in individuals.
4. A good listener. When someone is talking to him, the leader is alert and shows it. He concentrates on what the speaker is saying. He knows something about listening skills in man-to-man communications.	4. A poor listener. This person has never learned how to listen. He is a poor communicator because he is a bad receiver.
5. A prompt disciplinarian. The competent leader knows that he should apply disciplinary action as soon	5. A procrastinator in matters of discipline. Long delays in applying needed disciplinary

Positive Leadership Action	Negative Leadership Action
as possible for maximum effectiveness and consistency of action. He also makes his action impersonal.	action cause it to lose some of its effectiveness and often awakens deep resentment in the individual.
6. Straightforwardness-openness. A good leader gives an individual a straight answer or he refuses comments if he cannot give such an answer. This does not mean, however, that he is blindly blunt or that he is undiplomatic. But he does not manipulate the truth to serve his own purposes.	6. Deviousness. Some individuals almost always act in a devious manner. One is never certain whether they are telling the whole truth or partial truths. One never knows what underlying purpose they have in mind. They are often schemers whose actions are either unethical or lie in that gray zone between ethical and unethical conduct. Once a leader gets a reputation as a devious person, he is not trusted.
7. Supports his staff. The strong leader builds loyalty by giving solid and consistent support to his staff. They know they can count on him in tough situations even at the risk of his own position.	7. Wishy-washy in his support of staff. There are few patterns of leadership action that hurt morale and damage loyalty more than taking a wishy-washy, non-commital stand. Besides weakening loyalty, the staff will avoid necessary risks if they think that their leader will not support them.
8. Gives credit when credit is due. The strong confident leader always seeks to give his staff and others credit for achievements. He makes it a point to always acknowledge their contributions. He is generous in sharing credit even when he himself is mainly responsible for an accomplishment.	8. Hogs the credit or falsely takes credit. Some individuals who hold managerial positions are very stingy in acknowledging the contributions of others. This type not only creates resentment but kills initiative.
9. Provides opportunities for growth and development. The alert leader is always looking for ways in which he can help individuals to develop and advance. He is not only highly receptive to training, but actively promotes it.	9. Takes little or no interest in the growth and development of the staff. He is indifferent. His interest is sometimes solely the job, not people. To this individual, training is largely a waste of of time and money.

Positive Leadership Action	Negative Leadership Action
10. A cooperator and team player. The competent leader knows that cooperation and teamwork are essential for organizational effectiveness and accomplishment of objectives. Although he does not compromise his principles, he does try to find common grounds for acceptable compromises in areas of differences.	10. A loner. This person is so much of an individualist that he cannot act as a good team member, nor does he know how to compromise when compromise is essential.
11. Receptive to new ideas. The leader is willing to look at a new idea on its merits. His people know that he welcomes new ideas, will try to evaluate them carefully and impartially, and will try to put them into effect if they are worthwhile. As a result he creates a positive climate for new ideas within his organization.	11. Negative toward new ideas. He has a constantly negative attitude toward ideas. His first reaction almost always is, "It won't work." He is basically a negative person. Sometimes he is a jealous person who does not want anyone to receive credit for something new.
12. An innovator. The modern leader knows that he must not only be receptive to new ideas but must find and apply new approaches and techniques.	12. A standpatter. This person is the type who says, "The method has worked O.K. for the past fifteen years. Why should we change now?"
13. Recognizes and praises good work and outstanding accomplishments. The leader knows that people both need and want recognition as individuals and acknowledgement of good work.	13. Indifferent. Rarely utters a word of praise or looks at people as individuals, but is often quick to criticize. Basically, this person does not like people.
14. A firm stand. The strong leader takes a stand on issues. He is not blindly stubborn but holds fast to his position when he thinks he is right.	14. Rarely takes a strong stand. This individual wants always to be on the winning or the popular side. He wets his finger and holds it up to see which way the wind is blowing. Gets the reputation as an opportunist.
15. Objectivity. The good leader tries to minimize his bias and to deal with issues and people in an objective way.	15. Lets personal bias, likes, and dislikes unduly influence him. Sometimes he actually takes pride in his prejudices.

ABSENTEEISM

Absenteeism by people who are not sick can upset the operation and maintenance of your system and undermine the moral of those staff members who report to work regularly. Some employees believe that they have the right to use sick leave for additional paid time off. Such absences are annoying, increase costs, and upset other staff members. Increasing the size of the staff to cover these absences is uneconomical and foolish. Many approaches have been taken to curb unjustified absences (30). The degree of success of each approach depends on staff attitudes, the firmness with which the approach was applied, the support of the policy makers, and where they are involved, the unions.

Various techniques can be used to curb absenteeism.

- The supervisor must set an example by coming to work regularly and on time.
- Any unauthorized absence must be reported at least two hours prior to the scheduled start of a shift. Failure results in loss of pay or suspension.
- An employee absent two or more days in a row must present a medical certificate before returning to work.
- Spot checks should be made by having a supervisor or physician visit the home of the chronically absent employee. If he is not found at home or does not have an adequate excuse, he should be reprimanded and cautioned that a repetition could result in a suspension with a loss in pay or possible dismissal.
- Require a medical certificate for each leave, with or without pay, taken by an employee whose record shows frequent absences. Further, penalize his service record by adjusting for absences. This particular technique is important because the good worker will not develop a "taken for a sucker" attitude.
- Permit the accumulation of unused sick leave time up to sixty or more days with the understanding that this accumulated time would be added to an employee's terminal leave upon retirement, or paid to his estate upon his death.
- Establish a policy to provide additional paid sick time where an excellent attendance record has been maintained and the work performance has been satisfactory.
- Experience has show that when the last two items are properly publicized they are effective in reducing absenteeism. They overcome the employee's fear that he may lose accumulated sick leave credit. The knowledge that additional sick leave may be granted during a long illness serves as an incentive to accumulate sick leave credit and to maintain a satisfactory performance record.

PROMOTION POLICIES

In every organization, a major factor in maintaining employee morale is the promotional system. It should be fair and impartial. There are few things that discourage an ambitious and competent person more than to believe that the system of promotion is unfair and not merit-oriented. He will often seek employment elsewhere. It is not enough for you to know that the system operates without bias; it is equally important that the employees believe and know that it is impartial. This does not mean that you should attempt to convince employees that a promotion system is fair when it is not. It must be truly one *without bias of any kind.*

You must let the employees know what the standards are, what promotional factors are involved, and how selections are made. It is always important to indicate what weight various factors receive. It is sometimes desirable, too, to tell people who fail to get promoted exactly why they fail. This task is often a distasteful one. Many managers do not like it and avoid it. Although a manager may not convince a doubting employee of the reasons he was denied promotion, the majority of employees will appreciate this information, provided they have confidence in the integrity of the manager himself. The failure to tell employees why they fail has two consequences. First, they do not know where they should try to improve their performance and they must fail again. Second, they will sometimes lose faith in their supervisor.

Seniority-oriented promotions are often made when they should be merit-oriented. Such promotions reduce employee initiative and ambition. If an organization is unionized, the seniority problem is even worse. Seniority often should be given some weight for certain positions. However, giving seniority too much weight will discourage younger, ambitious people. It will discourage work performance and self-development efforts. It will eventually lead to a mediocre organization.

COLLECTIVE BARGAINING AND CONTRACT ADMINISTRATION

For many years, city employees were represented by employee associations when they discussed matters pertaining to salaries, working hours, working conditions, and fringe benefits with the city council. In recent years, there has been a major effort by labor unions to organize public employees (36). Even the small- to medium-sized municipal wastewater treatment plant staff may now be part of a public employees union. You may have to conduct union negotiations.

Unions may influence the attitudes of your personnel. If the unions impose limitations on work areas, they can create an air of non-cooperation. On the other hand, they can also help promote a good relationship between management and labor, stressing the need for teamwork.

If your personnel are unionized, you must deal with the union business agent and sometimes with one or more representatives of the union who are public works employees. They are often called "shop stewards." Whatever their title, you will have contact with these individuals and must learn how to work with them. Besides good working knowledge and negotiating skill, good labor-management relations depend heavily upon the personalities involved. If there are personality clashes, there is bound to be trouble.

There are two major areas of labor-management relations: collective bargaining to establish contracts, and administration of the contract. Knowledge, skill, and experience are needed in the contract negotiations. Some practical points related to negotiating (34) are:

- Think in terms of good-faith collective bargaining. Give reasons for proposals offered, and present reasons why proposals are opposed. In this connection, do not assume that "inability to pay" is a good answer to a demand for raises. Even if there is a legal limit to raising taxes, there is great danger in relying on it as the answer. Such an "answer" implies that the economic demand is justified and it is just a question of "finding the money." When this is done, little or no effort is given to the analysis as to the real merits of the demand.

- Recognize unions as essentially political in nature and respect their chosen representatives. Do not surprise the union, and do not be tricky. Think of the long-term effects of actions you take, and the way you take them.

- Fight if you know you are right. Tools to manage and a merit personnel system are examples where a good rational fight can be waged. Remember, the burden of proof is initially on the party proposing any change.

- Avoid proposals that use a simple formula to solve a union request on a permanent basis. A proposal of 5 percent extra pay for shift differential or longevity is an example of this. You will get more mileage out of a cents-per-hour adjustment for such an item, since, as wages go up in the years ahead, you will have the opportunity to renegotiate the item.

- Remember, the management pay plan is stronger than anybody's word. The pay plan should not be "union made," but should reflect equity, merit, and performance.

- Subjects outside the scope of bargaining should be handled in a common sense way with a sincere public-interest orientation to keep them outside the scope of future bargaining.

After the labor contract is negotiated and signed, it must be administered. This takes skill and good faith on the part of both management and labor. Public works managers need training to know how to deal with labor representatives; otherwise, friction, and bad working relations are likely to occur.

Employee grievances may take a lot of time and effort. In unionized organizations, grievance procedures will often be spelled out in labor contracts. It is important that grievances be handled quickly and in an impartial manner. Undue delay usually causes trouble. Some points to remember are:

- Never make false promises.
- Whatever the provocation, keep your temper in leash.
- Do an adequate job of documenting disciplinary cases and other problems; you are likely to lose grievance cases if you do not.
- Catch and treat personnel problems early, otherwise they may become larger.
- Always stick to facts in labor disputes and insist that labor union representatives do likewise.
- Anticipate areas or situations where trouble is likely to arise with a union and prepare your strategy well ahead of time.
- At the end of every year give each employee a statement of the amount of money in the form of fringe benefits that has been spent on him. Many employees are unaware of these figures.
- Be careful not to overstaff; it will be difficult in unionized organizations to reduce labor forces.
- Do not surrender your rights to install work measurement and performance standards, ways to increase employee productivity, or ways to reduce labor costs in collective bargaining negotiations.
- Hold fast to the right to have contracts with individuals or private consultants to carry out any type of work for your organization.

9 PUBLIC RELATIONS

ROUTINE PUBLIC CONTACTS

- Telephone calls
- Correspondence
- Unplanned visits

RELATIONS WITH OTHER DEPARTMENTS OR AGENCIES

- Don't air internal conflicts
- Maintain good relations with other agencies

PUBLIC INFORMATION PROGRAMS

- News releases
  - Example
- Public presentations
- Plant tours
- Annual reports
  - Major events
  - Service population
  - Financial statement
  - Operating data
  - Summary

SECTION 9

PUBLIC RELATIONS

Your wastewater system exists to serve the needs of the public and you will have truly *public* relations. Whether these relations are good or bad can have a major influence on how successfully your system will operate. Good public relations greatly improve the chances that you will be able to have competitive salaries and be able to obtain funding for system improvements. Good public relations depend on many factors other than your ability to issue good press releases and compete for news media attention - factors which often are first throught of when the term "public relations" is used. Sound and efficient operation are essential to good public relations (37). No amount of publicity can hide poor operations. However, sound policies and efficient service alone may not win public support. It is important to both do a good job and to let the public know about it. A key to good public relations is the routine public contact during the course of billings, handling complaints, answering inquiries, etc.

ROUTINE PUBLIC CONTACTS

Many of your contacts with the public occur when a customer calls by telephone. Your telephone manners are very important in creating a friendly atmosphere. The following guidance has been developed (38):

- Answer calls promptly. Your conversation is off to a favorable start if you answer promptly, on the first or second ring, if possible.
- Extend a pleasant greeting. You will make friends by greeting the caller in a friendly, courteous manner. Be alert, enthusiastic, and sincere.
- Answer by identifying yourself. It is easier if the caller knows at once to whom he is speaking. Say: "Wastewater Department, Allen (or Mr. Allen) speaking."
- Leave word when away from the phone. Leave word where you can be reached and when you will be back with the person who answers your phone while you are gone.
- Show real interest in the conversation. Don't handle it as just another crank call.
- Be sympathetic. Don't take the attitude that your utility never makes mistakes.
- Be responsive. If you can't answer the question on the spot, call back. Don't make the customer call again.

- Be patient. Don't cut the call short; let the caller finish what he has to say.

Handling customer complaints offers an opportunity to improve your public relations. Most customers don't call unless they receive poor service or are faced with an immediate problem. Since the customer feels he has a justified complaint, it won't do any good to bluntly tell him he is mistaken. Courtesy and diplomacy are more effective. When a citizen has aired his complaint, he feels better about it, especially if he has a receptive listener.

It takes self-control to listen to complaints, but this is what must be done. If the complaint is valid, you should acknowledge it and say what corrective action you will take. You should not make promises just to get rid of the individual or forget what you said you would do.

You should set up adequate procedures to handle citizen complaints and decide how much time to spend on them. Most citizens who telephone or who call in person want to talk to the "head man." Some of this is necessary, but don't let your management duties suffer because of it.

While you are correcting a problem, the complaining customer should be kept informed of what is being done in his behalf. When the problem is solved, give him a brief, accurate and easily understood report. Several weeks after the condition has been corrected someone should make a telephone call to ask if everything is satisfactory.

Some of these procedures may seem so obvious or unimportant that it is difficult to understand why they are frequently neglected. Some of these suggestions may add steps to existing procedures for handling complaints. Even if your complaint-handling procedures seem satisfactory, re-examine them periodically to see if they can be improved.

Your correspondence is also an important public relations factor. Many officials who are concerned about the citizen's interests in face-to-face contacts are very careless in their correspondence. They will allow letters to go unanswered; they are abrupt or even rude in their wording; they use dull, stilted, "business English;" and they add the final insult by using a rubber stamp signature. Letters are substitutes for face-to-face contacts; the public relations requirement in face-to-face contacts also applies to correspondence.

The following are points to remember:

- Write in a friendly style
- Be clear, brief and accurate
- Put the most important points first
- Use non-technical language
- Check facts and review letters carefully
- Don't send out letters with messy corrections, typographical errors, smudges, etc.

You must also remember that the public will form impressions of your operation from what they observe when they come to your office, plant, or city hall. The employees they encounter should provide prompt, courteous attention.

The behavior of personnel will have a bearing on the citizen's impression. Employees who are reading or eating at their desks or who are engaged in lengthy personal conversations with their colleagues or on the telephone create a poor impression. A room should be set aside in which employees can take their lunch or coffee breaks.

Citizens will also carry away a favorable or unfavorable impression of a government from the appearance of its buildings, offices, and equipment. Buildings and grounds should be well maintained, offices should be clean and neat, and equipment should be kept in good condition.

RELATIONS WITH OTHER DEPARTMENTS OR AGENCIES

A factor having an important bearing on public relations is the relationship between your department and the other departments and agencies of the municipal government. Some shortsighted department officials make public issues out of internal conflicts (5). They carry on feuds with other departments; they make derogatory remarks about other departments when talking to people; and they announce that their department is the one bright spot in the municipal picture. The result of these conflicts is usually that the public believes most of the unfavorable things said about the others and little of the good that a department claims for itself. Friction between departments cannot be eliminated entirely, but there is no excuse for ruining the public relations of the entire local government by public exposure of internal disputes.

To improve public relations, establish cordial relations with your governmental neighbors and don't try to improve your image at the expense of other departments. This advice applies to relations with other municipalities and with agencies of federal, state and county governments.

PUBLIC INFORMATION PROGRAMS

A good guide to public information programs is "Public Information Handbook," (39) available from the Water Pollution Control Federation. It tells how to run an organized public information program without hiring a professional public relations consultant.

Among the key ingredients in an effective public information program are:

- News releases
- Public presentations
- Plant tours
- Annual reports

News Releases

The news release is probably the most commonly used method of getting information to various news outlets such as newspapers, magazines, radio and television. A news release is a written version of the story you wish covered by the news media. In most cases all the basic information will be contained in the first few sentences or paragraphs. These are the "who, what, why, where, and when" that should be in the opening sentences of any release. The remainder should further discuss these facts, simply and clearly, without repetition.

A news release should include the name, address, and telephone number of the originator or someone who can supply additional data or answer questions, and when the story can be released (such as "For Immediate Release").

Figure 26 is an example news release. The release should be typed on your letterhead. News releases, such as the example, describing the achievements of the utility staff serve the purposes of both public information and employee recognition. Other activites which may justify news releases include plans for plant expansions, plant open houses, planning meetings, presentations at state or national meetings, and construction contract awards.

Some key points to remember about news releases are:

- The story must be timely - not old news.
- Type the release in double-spaced format with wide margins.
- Double check the release for spelling, facts, and figures - never exaggerate the facts.
- The first paragraph should answer the questions: who, what, where, when, and why.
- Don't use too much detail - use a separate data sheet for the editor's reference if the story requires such backup.
- Keep a current list of newspapers and radio or TV stations that may be interested in your stories.
- Make sure that the release is sent to news outlets that can use it and is addressed to the staff member who is most concerned.

Frequently, a release will be accompanied by one or more photographs. In fact, a photograph with a short descriptive caption can in itself be a news release. For example, a picture of a ground breaking ceremony or a ribbon cutting announces that work is underway or a job is completed and in service. Some points to remember in using photographs:

- Try to avoid obviously posed pictures
- Use a professional photographer
- Provide 4" x 5" or 8" x 10" glossy prints

Millbrook Wastewater Utility District
246 Main Street
Millbrook, California
916-421-5711

March 15, 1979 Contact: R.J. Smith, Manager

FOR IMMEDIATE RELEASE

MILLBROOK'S WASTEWATER OPERATORS RECEIVE RECOGNITION

Millbrook, California - Two of Millbrook's wastewater treatment plant operators, Bill Johnson and Tom Wilson became certified operators under a State of California certification program. R.J. Smith, Wastewater Utility District Manager, said that their certification at the highest level (Grade V) recognized by the State reflects the unusual skill and dedication of Millbrook's staff. "Of the 600 certified operators in California, only 41 are certified at the Grade V level and most of these are working in communities far larger than Millbrook," Smith reported.

Johnson and Wilson, who have been on the District staff since 1968 when the most recent District plant expansion was completed, have received awards from the California Water Pollution Control Federation for their operation of the Millbrook system.

Figure 26. Example news release.

- Make sure the picture background is clean and neat and doesn't show fire or safety hazards.
- Take two of every key photograph
- Keep a current file of plant and personnel photographs
- Use black and white film for prints to be published
- For any photograph issued with a release, prepare a caption on a separate sheet of paper and paste it to the print.

Public Presentations

Speaking before local groups can be valuable in winning support for a program or spreading specific information. Many clubs, social organizations, political groups, and the like have a program chairman who schedules speakers. The early fall is a good time to approach local organizations, either by mail or telephone, with a proposal that water pollution control be included in the program plans. It is wise to include a list of possible topics, making sure it is flexible enough to fit the interests of the specific group. In identifying potential groups for presentations, do not neglect the young people. Speaking at schools can be a most rewarding experience to speaker and audience alike.

Some key points related to public presentations are:

- Use staff members who make *interesting* presentations for public speaking - you should listen to their presentations prior to the public meeting.

- Keep a good file of slides and other good visual aids. Do not over crowd the slides - make sure they can be read from the back of the room!

- Do not talk down to your audience regardless of their age or attitude.

- Keep the tone of the talk conversational to maintain the listener's interest.

- Be prepared to answer questions.

- Be sensitive to time constraints - running over your allotted time (especially at groups who meet at lunch time) leaves a bad impression.

Plant Tours

Plant tours are exceptional opportunities for talking to a "captive" audience with an expressed interest in what's happening. Giving tours depends on the accessibility of the plant, its physical arrangement, considerations of safety and good sense, sufficient parking facilities, etc.

A plant visit must be interesting, informative, and of some value to both the visiting group and the plant. If these requirements cannot be satisfied, it may be advisable to avoid tours.

For plant tours, keep the following in mind:

- Plan your tour presentation in advance. Place yourself in the position of an uninformed visitor and go through the plant from end to end.
- Prepare a plant map and tour summary to hand out to visitors.
- Be prepared to answer pointed questions - somebody in the group may be hostile to public employees.
- If there are more than 15 people in the group, split up into two or more groups each with a tour guide.
- Tailor the length of the tour to the interest and age of the group - one or two hours may be appropriate for engineering students, but not for a junior high group.
- Do not "snow" the audience with technical terms.
- Make sure there are no safety hazards along the tour route.
- If your normal housekeeping is not something you want the public to see, correct the housekeeping rather than eliminate tours. Obviously, a poorly kept plant will make a poor impression.
- Send a follow-up letter thanking the group for their interest and extending an invitation for another visit.
- Keep a log of plant visitors.

Annual Reports

An annual report on the wastewater system offers an excellent chance for positive public relations. The report should have a narrative discussion on the year's activities, the plans for service, and interesting statistics. Small utilities have found the following approaches useful for distributing their annual reports:

- Present a summary report in the daily paper or as a Sunday supplement.
- Print the summary report so it is a self-contained mailer for distribution to all customers.
- Have a printed and bound copy of the complete report available at the utility offices.

The annual report should contain (the last item may be only in the full report and not the summary report):

- A discussion of the major events (for example, major additions to the plant, major repairs or replacements, etc.) of the past year and the plans for the next year. You may want to include a comparison of your wastewater service charges with those of neighboring towns.

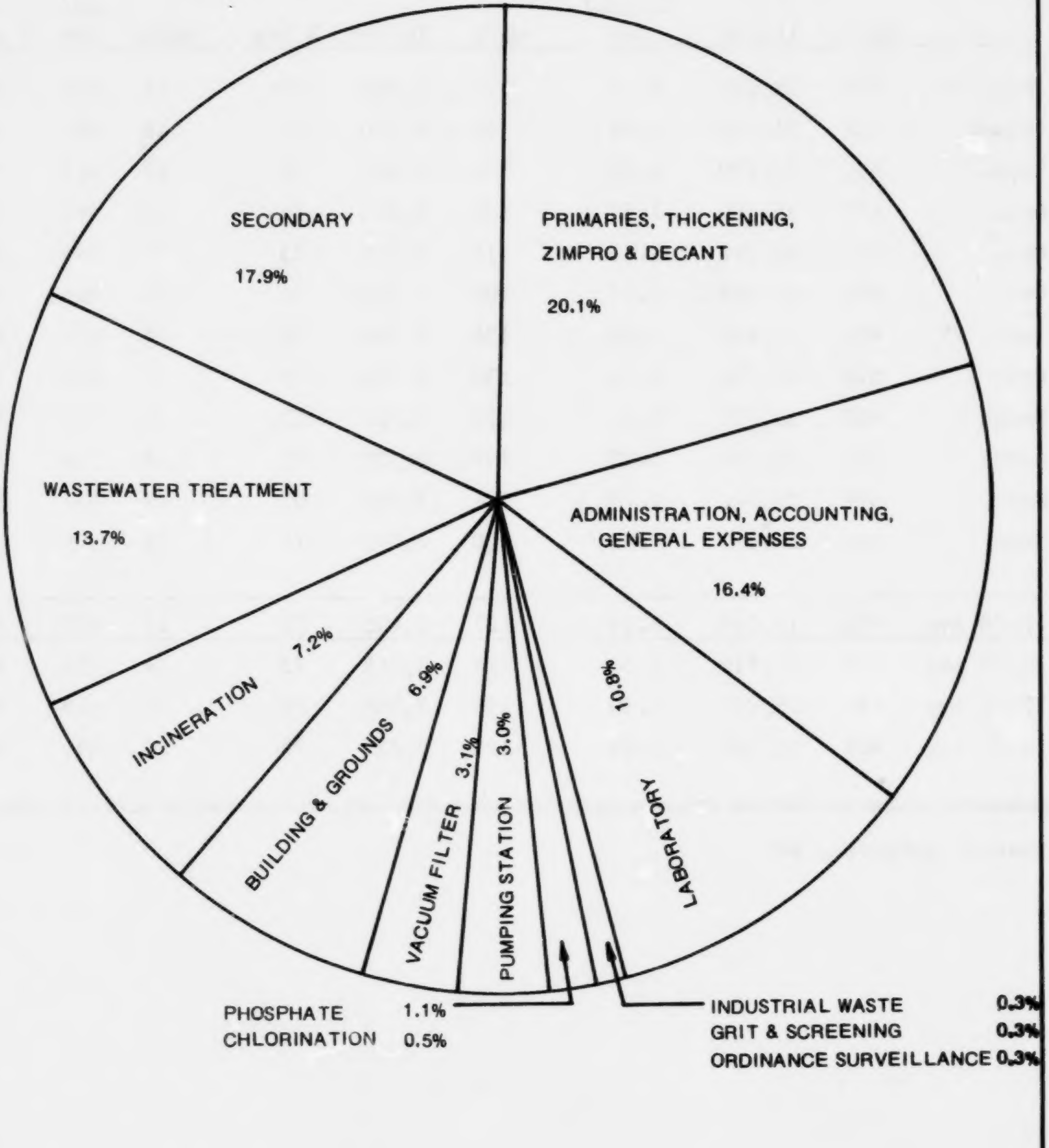
- A summary table showing the population and industries served, the number of connections, the average daily and per capita flows, and the treatment standards versus treatment performance.

- A description of the receiving water body quality and the contribution that the treatment system makes to maintaining uses of the receiving water.

- The financial balance sheet for the last year - preferably the last three to five years with a description of the meaning of the balance sheet items. "Pie charts" showing costs and revenues may also be useful (Figure 27).

- Monthly operating data for the major unit processes and/or treatment parameters (see Table 10 for an example) and an overall summary (Table 11).

The report organization, typography, illustrations, and arrangement should be carefully and neatly done to make a favorable impression. If your utility has not previously used the annual report as a public relations tool, you should contact other utilities to get copies of their reports.



Source: Reference 40

Figure 27. Expenditure distribution of operating funds.

TABLE 10. TOTAL SUSPENDED SOLIDS (NON-FILTERABLE RESIDUE)

	Raw influent			Primary effluent			Final effluent		
	mg/l	lb/day	lb/cap/ day	mg/l	lb/day	% rem	mg/l	lb/ day	% rem
July '77	501	13,610	1.18	127	3,360	75	14	374	97
August	438	11,950	1.04	126	3,370	72	18	464	96
Sept.	483	13,770	1.20	123	3,450	75	13	364	97
Oct.	489	15,160	1.32	132	3,910	74	16	463	97
Nov.	441	12,790	1.11	115	3,220	75	16	445	97
Dec.	402	12,080	1.05	106	3,150	74	18	521	96
Jan. '78	405	12,460	1.08	126	3,280	74	16	437	96
Feb.	515	12,730	1.19	130	3,210	75	16	403	97
March	489	13,070	1.14	132	3,510	73	20	523	96
April	461	13,980	1.22	131	4,020	71	18	544	96
May	689	20,540	1.79	116	3,600	83	17	557	98
June	382	10,690	.93	100	2,780	74	12	346	97
77-78 Avg	438	13,569	1.19	122	3,405	75	16	453	97
76-77 Avg	436	11,915	1.04	122	3,269	72	14	356	96
75-76 Avg	486	15,070	1.30	116	3,598	76	16	519	95
74-75 Avg	408	12,569	1.09	125	3,736	70	16	495	95

Source: Reference 40

TABLE 11. SUMMARY OF OPERATING RESULTS

POPULATION	
Estimated connected - Grand Haven	9,000
Estimated connected - Spring Lake	2,500
	11,500
Population Equivalent - BOD	63,359
Population Equivalent - SS	61,667
(Population Equivalents are calculated on the basis of raw sewage - 0.17 lb of BOD/cap/day and 0.22 lb of SS/cap/day)	
RAINFALL	
Monthly average, in.	3.05
SEWAGE	
Total mil gal treated	1,216
mil gal per day	3.3
gal/cap/day	290
ACTIVATED SLUDGE	
mil cu ft used	3,170
cu ft air/gal sewage	2.6
cu ft air/lb BOD fed	1,332
cu ft air/lb BOD removed	1,413
cu ft air/lb MLVSS under aeration	423
Aeration, hr	5.28
Percent return sludge	58
Sludge age, days	7.9
5-DAY BIOCHEMICAL OXYGEN DEMAND	
Raw, mg/l	382
Prmary Effluent, mg/l	235
Final Effluent, mg/l	12
Influent, lb/day	10,771
Influent, lb/cap/day	0.94
Primary Effluent, lb/day	6,643
Percent primary removal	38
Final Effluent, lb/day	404
Final Effluent, lb/cap/day	0.04
Total plant percent removal	96
Lb applied per 1000 cu ft of aeration tank	44
Lb applied per 100 lb MLVSS under aeration	33

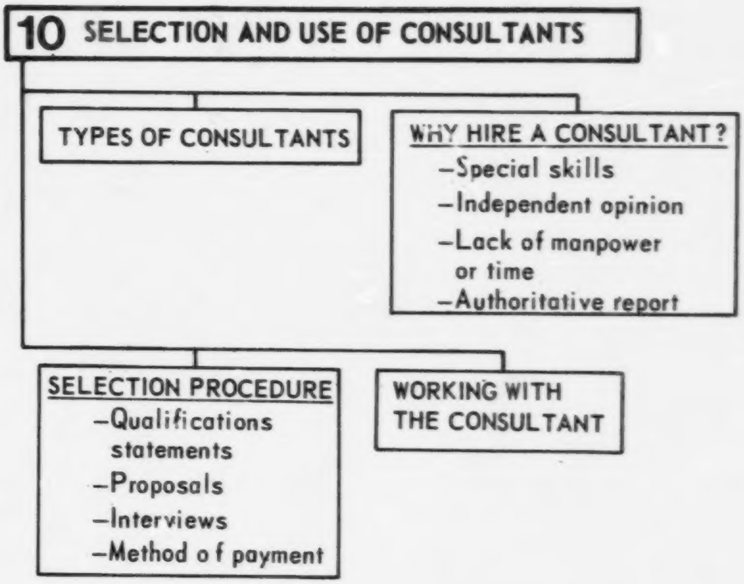
TABLE 11. (Continued)

SUSPENDED SOLIDS	
Raw, mg/l	438
Primary Effluent, mg/l	122
Final Effluent, mg/l	16
Influent, lb/day	13,569
Influent, lb/cap/day	1.19
Primary Effluent, lb/day	3,405
Percent primary removal	75
Final Effluent, lb/day	453
Final Effluent, lb/cap/day	.04
Total plant percent removal	97
Lb removed per mil gal treated	3,938
PHOSPHORUS	
Raw, mg/l	5.5
Primary Effluent, mg/l	3.3
Final Effluent, mg/l	0.7
Influent, lb/mo	4,641
Final Effluent, lb/mo	586
Total plant percent removal	87
Fe applied, mg/l	4.3
Total lb Fe used	43,307
Cost of Fe	$3,681.14
SLUDGE	
Primary Sludge, mil gal	6.34
Primary Sludge, mil lb	3.83
Waste Activated, mil gal	63.14
Waste Activated, mil lb	4.12
Wet Air Oxidation, mil gal	18.50
Wet Air Oxidation, mil lb	6.71
Rate, gpm	63
Reactor Temperature, °F	383
Reactor pressure, psi	309
Decant overflow, mil lb	2.20
Thickener overflow, mil lb	1.68
Vacuum filtered, mil lb	4.62
Filtrate, mil lb	.24
UTILITIES	
Electrical Energy	
Grand Haven Pumping Station total KWH used	250,080
Cost per KWH	5.09¢
Cost per mil gal pumped	$17.01

TABLE 11. (Continued)

Electrical Energy (continued)	
Spring Lake Pumping Station total KWH used	82,269
Cost per KWH	3.933¢
Cost per mil gal pumped	$25.30
Plant use total KWH	5,506,800
Cost per KWH	3.00¢
Cost per mil gal treated	$135.26
Total electric cost for plant use and pumping	$178,981.14
Total KWH used	5,839,149
Total cost per KWH	3.07¢
Total cost per month	$14,915.10
Total cost per day	$490.36
Total cost per mil gal	$147.21
Gas	
Cubic feet for heating and operating	15,835,100
Total gas cost	$34,013.92
Cost per 100 cu ft	21.40¢
Water	
Gallons plant use	18,118.00
Total water cost	$4,413.43
Cost per 1000 gal	24.40¢
COST	
Net cost of wastewater treatment	$756,303.03
Cost per mil gal wastewater treated	$622.12
Cost per ton of influent BOD	$384.75

Source: Reference 40


10 SELECTION AND USE OF CONSULTANTS
TYPES OF CONSULTANTS
WHY HIRE A CONSULTANT?
–Special skills
–Independent opinion
–Lack of manpower or time
–Authoritative report
SELECTION PROCEDURE
–Qualifications statements
–Proposals
–Interviews
–Method of payment
WORKING WITH THE CONSULTANT

SECTION 10

SELECTION AND USE OF CONSULTANTS

TYPES OF CONSULTANTS

Consultants may be used for the following purposes:

- Planning and design of new facilities
- Solving operation and maintenance problems (See Section 11)
- Operating the treatment plant (see Section 11)
- Providing financial audits
- Advising on financial matters such as bond issues
- Improving public relations
- Solving management advice
- Managing the construction of a project

WHY HIRE A CONSULTANT?

You may decide to hire a consultant because you (41):

- Need skills that are not available on your staff
- Need an independent opinion
- Do not have the time or staff available to work on the problem
- Need an authoritative report for your superiors or a state or federal agency

SELECTION PROCEDURES

The first step in selecting a consultant is to write down what you want him to do and what qualifications he should have. You should then let consultants know you may be needing their services. This can be done by advertisements in major metropolitan newspapers in your area and in professional trade journals. You may also send the proposed scope of work directly to consultants which have been recommended to you by other towns or districts. You should ask those that respond to send their general qualifications to you.

The qualification statements should be reviewed by at least a three-person review board. At least one of the board should be a professional in the consultant's field. Take the time to call some of the firm's other clients. Ask these other clients:

- Did the firm perform as expected?
- Was the work done on time?
- Was the work done within budget?
- Would you use the firm again?

You should make a list of criteria which will be used to rank the firms (such as specialized experience in your problem area, location, adequate staff size to do your work, ratings by other clients, etc.). You may wish to use more professionals in the consultant's field to serve as (or on) the review board. Nearby universities, professional associations, and other government agencies are possible sources of professionals for your review board. After rating the qualification statements, select 3 to 5 firms to prepare detailed proposals and to interview for the work. The same review board should be used for the interviews.

In reviewing the proposals, concentrate on the qualifications of the firm's people that will be assigned to your project. Insist that the proposed project manager for your work be present at the interview.

After the proposals and interviews are evaluated, negotiations with the top-rated firm should be held to finalize the scope and cost of the work. There are several basis for calculating costs (42):

- Per Diem - A certain cost per day is paid for services with this approach. The daily rate includes overhead and profit but not expenses such as travel or meals. This approach is often used for work which is hard to define in scope and is only a few days in duration; for example, troubleshooting an O&M problem or testifying in court.

- Cost Reimbursement - Services are paid on the basis of salary cost, overhead, and a fixed profit. This is often used for design contracts and studies. A cost ceiling or budget amount which cannot be exceeded is often established.

- Lump Sum or Fixed Price - The scope of work is accomplished for a specified dollar amount. This approach is often used for routine sampling programs or reports of clearly defined scope.

- Retainer - This method is used when the need for a consultant's services is expected to last for a long time. It insures that a certain person will be available as needed. To guarantee these services, a certain amount is paid at regular intervals for which the consultant provides certain specified services as well as being available, generally on a per diem basis, as required by the client.

If EPA grants are involved, there are regulations related to consultant selection and contracts that must be followed. These regulations affect:

- Method of payment - for example, per diem contracts are usually limited to $10,000 or less; percentage of construction costs as a basis for fee is prohibited

- Public notice - procedures vary with the size of the project

- Evaluation procedures - certain criteria must be used

- Negotiation procedures

- Basis for cost proposals and cost review
- Required contract provisions

You should obtain a copy of the current EPA regulations from your EPA regional office (40CFR, part 35.937).

A useful reference for consultant selection and contracts is "Consulting Engineer-A Guide for the Engagement of Engineering Services (47), available from the ASCE.

WORKING WITH THE CONSULTANT

Once the consultant is under contract, you should:

- Review with him what you want done once more to make sure there is no confusion.
- Make sure the consultant knows who to report to on your staff and which staff members have information he may need.
- Provide any facilities or services (such as office space or secretarial help) that will make it easier for the consultant to do the job.
- Meet regularly to discuss his progress to make sure that he stays on the track.
- Don't treat the problem as solved just because you've hired a consultant. You must have a continuing commitment to solve the problem and work with the consultant until the solution is developed.

11 CONTRACTS FOR OPERATION AND MAINTENANCE

FULL OPERATIONS AND MAINTENANCE CONTRACTS

- Reason for private O & M contracts
- How are these contracts established?
  - –Scope of services
  - –Treatment conditions
  - –Plant staffing
  - –Sludge handling
  - –Plant improvements
  - –Terms and conditions
  - –Regulatory reporting
  - –Performance guarantee
- Disadvantages of full O & M contracts

OPERATIONAL ASSISTANCE CONTRACTS

–Federal grant funding to 75% for plant startup and operator training

SECTION 11

CONTRACTS FOR OPERATION AND MAINTENANCE

Operating and maintaining today's complicated wastewater treatment facilities can be a major problem for the small- to medium-sized community. The skills required for new plants are often considerably higher than in the past. Many communities don't have the financial resources to hire, train, and keep adequate personnel. Some may overlook the need for upgrading staff to operate the new facilities. As a result, many new facilities may fail to meet discharge standards. An approach to consider is to hire someone on a contract basis to operate and maintain the treatment plant.

The concept of contracting areawide management is currently being studied and tested. Such a plan would be highly site specific and affect only a few plants nationwide. Detailed discussion of this concept is not included since it may lead to confusion among the plant managers not affected by it.

Several private organizations have been formed to contract operating and maintenance services ranging from full-service contracts to giving special advice on operations. Under a full-service contract, the contractor has complete responsibility for operation and maintenance of the plant. The plant personnel become employees of the management organization. Several consulting engineering firms and other consultants provide advice on operations. These firms review practices and procedures and advise the plant staff of changes to improve performance, reduce operating costs, etc. The firm has no managerial responsibility for plant operations. These approaches are described in greater detail in the following sections.

FULL OPERATION AND MAINTENANCE CONTRACTS

There are several organizations that provide full operation and maintenance service. The extent of services can be tailored to the specific desires of the community. One organization provides full operation and maintenance for five municipal wastewater treatment plants ranging in size from 4.7 to 21 mgd. Another provides varying levels of operation and maintenance service at six facilities.

Reasons for Private Operation and Maintenance Contracts

Under what conditions should a community consider contracting with a private firm to operate and maintain the wastewater treatment facilities? What are the key factors contributing to such a decision? You must analyze physical, financial, legal, and political factors to determine what is in the best interest of your community.

Currently, less than two dozen community treatment plants are operated by contractors. In all but a few cases, the contractor was hired because the municipality didn't or couldn't operate the plant satisfactorily. For example, effluent discharge standards weren't met or persistent odor problems caused complaints. In several of these installations, the staff didn't have the skills to operate complicated solids handling facilities; this led to overloading the plant and odor problems. One community hired a contractor to eliminate a complex union problem. It wanted to prevent potential labor problems from leading to violations of discharge standards. At a new regional plant without previous staff, the elected directors chose to contract operations and maintenance with a private organzation. High operating costs have caused others to consider the contract approach.

How Are These Contracts Established?

What is involved in establishing a full operation and maintenance contract with a private organization?

Once the community has decided on a full operation and maintenance contract, it requests proposals from organizations that offer these services. The preparation of a detailed proposal requires a review of the operation and management of the plant and an inspection of the facilities. This analysis will reveal whether the plant is physically capable of meeting treatment objectives if operated and maintained properly. From this information, a plan outlining proper operation and expected performance can be developed. The contractor must also decide if the facilities can be operated within the existing budget. The contract will be for a fixed annual fee and will have a performance guarantee.

Competitive proposals should be sought from several organizations. You should prepare detailed specifications to compare the proposals. Major items in the specifications may be:

- Scope and extent of services
- Treatment conditions
- Plant staffing
- Sludge handling and disposal
- Plant improvements
- Terms and conditions of the contract
- Reports to regulatory agencies
- Performance guarantee
- Owner's rights of inspection

Scope and Extent of Services--

The requests for proposals must completely define the scope and extent of services to be provided and must contain guideline specifications to allow bid comparisons. Most full-maintenance contracts are similar; however, there are some differences in the services being offered. For example, some contractors will assume operation and maintenance responsibilities for the collection system and pumping stations, as well as for the treatment plant.

The extent of financial responsibility for repair and replacement of equipment during the contract period can vary. Some organizations assume full financial responsibility for repair or replacement of an equipment item; others establish a maximum allowance determined by equipment age, physical conditions, etc.

Some organizations provide a performance guarantee which includes the financial responsibility for fines levied for effluent discharge violations. Any limitations on the amount of the fine must be clearly defined in the proposal. It is important to remember that the owner has the ultimate legal responsibility for compliance with discharge requirements, regardless of what contractual arrangements have been made for operation and maintenance.

The requests for proposals must state what portion of the costs of utilities, chemicals, maintenance materials, etc., will be paid by the management organization.

Treatment Conditions--

The contract should state the wastewater flows and characteristics to which the performance guarantee applies. Such factors as the average daily flow, peak daily flow, peak hourly flow, influent pH range, total and soluble BOD (30-day average), suspended solids (30-day average), and ratio of peak daily to average daily loading must be specified.

Plant Staffing--

You must consider how and to what extent the contractor proposes to use existing staff. Since private operation of publicly-owned treatment facilities can be a sensitive issue, maximum support for private operation must be gained by assuring employees of the city that they will not lose their jobs.

Generally, the contractor will utilize as much of the existing staff as possible. The contractor will use one of its trained employees to manage the plant and train an assistant. The services of home office support personnel will be used to train existing staff and establish new operation and maintenance procedures. Most of the plant operation staff will likely be existing employees of the city.

Sludge Handling and Disposal--

The handling and disposal of waste solids and sludges must be defined in the request for proposals. If waste solids are to be hauled from the plant and disposed of by landfill or land spreading, the procedures for this service must be defined in the scope of the contract.

Plant Improvements--

Full operation and maintenance contracts don't include construction of plant improvements or additions. The contract may include minor plant or process modifications required to meet performance standards. If, for example, during a contract period a major plant modification is required (such as the addition of a new clarifier or pump station), the contractor will often define what is needed and provide design recommendations for the improvement. The contractor will then give the responsibility of design, equipment purchase, and construction to the owner. However, in some cases, the contractor will design minor improvements with its own engineering staff and will assist the owner in obtaining the equipment and administering a construction contract. These services are outside the general scope of the management contract and must be negotiated separately. In developing the contract specifications, the limits of responsibility for capital improvements must be clearly defined.

Terms and Conditions of Contract--

The contract must fully define the terms and conditions covering financial and legal responsibility of each party, such as price, duration of contract, and method of payment.

Provisions for cancellation of the contract by either party and any financial liabilities of either party at time of cancellation must be included. Generally, contract cancellation can be initiated by either party after filing written notice 90 to 180 days prior to the cancellation date.

All contracts will have clauses for inflation in the cost of utilities, materials, chemicals, and, in some cases, labor. Some organizations offer an annual fee with fixed labor costs for the duration of the contract, in which case the contractor absorbs increases in labor costs. Others include inflation factors which are tied to national indices, such as the Consumer Price Index. These inflation factors can have a significant effect on the cost over the life of the contract and should be established and agreed upon when negotiating the contract.

Public liability and property damage insurance covering operations of the contractor at the publicly-owned wastewater treatment plant must also be provided. The amount of this insurance must be clearly established during contract negotiations.

A performance bond should also be considered to insure that the contract is carried through to completion. In the case of a default, the bond would be used to pay off the community to restore the plant to public operation.

Contracts must contain a "hold harmless" clause protecting the community from any liability for death, injury or personal property damage caused by the contractor's operation of the treatment facilities. Further, liabilities should also be assigned for any damage or injury occurring from the accidental discharge of wastewater.

The contract should contain provisions for inspection of books and records to determine if increases in compensation are justified and for general compliance with provisions of the contracts.

Reports to Regulatory Agencies--

The contract should define the nature and extent of operation and monitoring reports to be prepared and submitted to regulatory agencies. Generally a contractor will do this in a full operation and maintenance contract.

Performance Guarantee--

In addition to full financial responsibility for operation of the treatment facilities, some contractors will offer a performance guarantee. This guarantee transfers the responsibility for meeting effluent standards from the community to the contractor. However, the legal responsibility for meeting discharge requirements is still the owner's, regardless of the contractual arrangements which have been made for plant operations and maintenance. Within certain limits, the contractor may assume financial liability for any fines for nonaccidental violations of the discharge standard. The extent to which the contractor will stand behind his performance guarantee and his responsibility for any possible fines must be clearly established during contract negotiations.

Disadvantages of Full Operation and Maintenance Contracts

There are certain disadvantages in contracting with private firms for operation of publicly-owned treatment works. Since the contractor operates with a profit incentive, there is a danger that a certain amount of corner-cutting may occur. One area of particular concern is mechanical equipment maintenance. Some contracts exclude the cost of equipment repair or replacement or provide only a limited allowance. Under these conditions, the community doesn't have assurance that the equipment will be properly maintained. The contract should clearly describe the type and amount of maintenance to be provided. Equipment repair and replacement allowances should be realistic and enough to offset the anticipated expense. The higher the allowance, the greater the incentive for the contractor to maintain the equipment. Prior to the negotiation of a service contract, the community should perform a detailed inventory, inspection, and assessment of the condition of all plant equipment. At this time, assistance from equipment manufacturers or special consultants will be helpful. A specific maintenance program must be detailed and agreed upon during contract negotiation.

There is another potential disadvantage of a full maintenance and operation contract. Where prior operating history and costs are not available (such as for a new plant or for one with major improvements), it is difficult to know whether the fee being proposed by a private organization is reasonable. Securing a fair price for the services is a problem, unless they are sought on a competitive basis. Presently, there is only one major national firm offering full services. Under these circumstances, you should ask a consultant experienced in treatment plant operation and management to help evaluate the proposed cost. The consultant should review the proposed management and staffing requirments, operational costs, and maintenance requirements and advise the owner as to whether the services being offered and the associated fee are reasonable.

OPERATIONAL ASSISTANCE CONTRACTS

An operational assistance contract is quite different from a full operation and maintenance contract. The main difference is that the private organization doesn't assume administrative and financial control of the wastewater treatment facilities. Rather, this organization serves as a consultant, furnishing technical help to solve any treatment problems. It is retained by the community in a manner similar to the consulting contracts discussed in Section 10.

There are numerous organizations that offer operations review and consulting services to identify and solve treatment problems. These organizations have gained practical experience in the operation of treatment facilities. In addition, numerous consulting engineering firms have recently established operation and maintenance specialty groups. Some equipment manufacturers offer plant operational assistance services as well.

As in the case with the full operation and maintenance contracts, the consultant trains plant personnel and sets up proper operating and maintenance procedures. These services are often provided for a fixed fee negotiated annually.

With this type of contract, the community makes all management decisions and has the full responsibility for paying all operating costs such as salaries, utilities, chemicals, etc.

One firm indicated that at the request of a community, it will place one of its personnel in charge of plant operations to correct operational problems. Although plant staff are responsible to this manager for direction, he has no authority to hire or fire personnel. He has little power to correct plant problems related to personnel.

Plant performance guarantees are not usually offered by operational assistance consultants since they don't have total control over operation and management. One firm will assume limited financial responsibility toward meeting a plant performance guarantee if given enough authority by the community to have management control of the treatment facilities.

Correcting problems is more indirect with a plant operational assistance contract. The problem must be presented to the community official responsible for taking corrective action. Correcting process or mechanical problems may be fairly easy. Solving a personnel problem which is contributing to poor performance may be considerably more involved.

Operational assistance service can be very useful at plant startup. Under current EPA grant funding provisions, the federal government will finance up to 75 percent of an operator training program for the start-up of a community wastewater treatment plant currently under construction with an EPA grant. The consultant can provide on-site classroom instruction and "hands-on" experience in process and mechanical operations, maintenance, and safety and emergency procedures. The laboratory staff must also be instructed in sampling and testing procedures, data collection, and regulatory monitoring and reporting. The operations and maintenance manual is an important tool in plant start-up and must be updated and revised on a regular basis. The operations consultant can be very helpful in preparing this document.

To obtain operational services, you should contact various organizations offering them. Discuss your problems with them and decide if they offer appropriate services. Once you have narrowed the list to a responsive group of potential service consultants, ask for proposals defining the scope and extent of the services and a general fee structure. Compare the proposals using a standard set of guidelines to insure that all contractors will be furnishing the same services. From this review, you can select the firm best suited to your needs and negotiate with them. The fees and terms and conditions of the contract would be similar to other professional service contracts discussed in Section 10.

12 ENERGY CONSERVATION

THE NEED FOR CONSERVATION

- Shortages and rising costs

ENERGY USES IN WASTEWATER TREATMENT

- Liquid and solids handling processes

CONSERVATION POSSIBILITIES & PRACTICES

- Pump adjustments
- Pump maintenance and operation
- Plant lighting, heating & ventilation
- Screening & grit removal
- Sludge pumping
- Trickling filters
- RBC's
- Activated sludge
- Solids retention time
- Sludge dewatering
- Anaerobic digestion

RESOURCE RECOVERY PROGRAMS

- Anaerobic digester gas
- Gas production
- Systems to use gas
- Sludge utilization

SOLAR ENERGY

MANAGEMENT OF OPERATION

- Operating records
- Contingency plans
- Operator training

SECTION 12

ENERGY CONSERVATION

THE NEED FOR CONSERVATION

Many secondary and tertiary treatment plants require from 4 to 15 times more electrical power than the primary plants of the past. Because of this, there is a real need for energy conservation. Recent shortages and the high costs of electricity, fuels, and chemicals have become important influences in plant design and operation.

Until recently, little or no attention to the availability of the consumable supplies and utilities needed for plant operation has been given in treatment plant design. However, the fuel shortage in 1973-74 demonstrated how sensitive the supply of products and utilities is to a dependable supply of crude oil (43). In addition, there were shortages of some chemicals including lime and chlorine needed at wastewater treatment plants. While most chemicals and utilities are available in 1979, their costs have increased greatly over the last five years and will continue to increase in the future. You can make an important energy and resource conservation effort in your plant operation.

ENERGY USES IN WASTEWATER TREATMENT

Energy requirements in wastewater treatment are for wastewater pumping, primary treatment, secondary treatment, tertiary treatment in some cases, disinfection, building heating and cooling, and sludge treatment and disposal. Energy requirements for almost all wastewater and sludge treatment processes are given in a recent EPA report on energy, "Energy Conservation in Municipal Wastewater Treatment" (MDC-32), EPA 430/9-77-011 (44).

The EPA report showed that trickling filters with rock media require the least amount of energy of any secondary treatment method. Only a relatively small amount of energy is required for preliminary and primary treatment, disinfection by chlorination, and for building heating and cooling. Most of the energy required in a conventional wastewater treatment plant is for the secondary treatment system. Aeration energy requirements in activated sludge treatment are often the single largest energy use in a typical wastewater treatment plant.

Sludge treatment processes also require a lot of energy. Energy required for anaerobic digestion is affected by air and sludge temperature. Most energy is required to heat anaerobic digesters in colder climates.

CONSERVATION POSSIBILITIES AND PROGRAMS

This section discusses things that you can do to conserve energy in your treatment plant. These suggestions should be carefully considered for their full effect on the wastewater treatment system. Measures which may help one plant may not save energy in another or may cause process control problems.

You should be careful when reducing electrical power supplied for treatment equipment operation. Some may cause some loss in treatment efficiency.

Pump Adjustments

One of the major users of energy in most plants is pumping. Typically, centrifugal pumps use most of the total pumping energy. For a centrifugal pump, as the pumping head is increased, both flow and power consumption may be decreased. By partly closing (or throttling) the discharge valve, an artificial head is created. This causes a lower flow to be pumped and the power consumption may be reduced depending on the characteristics of the pump curve and the operating point. Such adjustments can be made during low flow periods or in initial phases of plant operation when flows are low. Be careful not to close valves so far that they plug or that velocities are reduced so low that solids settle in pipes. Any adjustments or changes in pumping should be very carefully assessed by someone familiar with your system and knowledgeable about pumping. Poor judgement may lead to increase in energy consumption and possibly dangerous operating conditions.

Changes in the type, number and speed of pumps may reduce pumping energy. If a pump is to be operated at a reduced capacity for a long time, energy can be saved by installing a smaller impeller in the same pump. This method reduces power consumption more than throttling.

Perhaps the most common method to vary pumping rate and conserve pumping energy for larger plants is control of pump speed. One way to do this is to change pulley sizes for belt-drives or reduce motors to lower speeds. Drives using manually adjustable pulley and belt systems, two speed motors, and various types of electronic drives can also be used. These methods require only that operating personnel turn a handcrank, push a button or turn a knob to adjust pump speed.

For centrigual pumps, reducing pump speed allows the use of the more efficient, full-size impeller and at the same time provides a quick, easy way to increase pumping capacity when it is needed. Operation at lower speed also results in a longer pump life.

When the replacement of existing pumps is being planned, consider variable speed pumps. Pump speed is regulated automatically by changing motor speed or using a variable speed drive between the pump and motor. Speed is controlled to pace the pump flow to items such as wet well level or discharge pressure. This method can save a lot of energy. However, the initial cost of the drive and controller and increased maintenance costs may be more than the savings in energy costs. Your consultant can determine if variable speed drives will save you money.

Propeller or axial flow pumps normally use more power when the discharge head goes up. Power used by positive displacement pumps is almost directly related to discharge pressure.

Energy savings with these pumping systems, particularly from positive displacement systems, can be obtained by varying pump speed. Nearly all of the speed control methods for centrifugal pumps may also be used for positive displacement pumps. Small positive displacement pumps, such as those used for chemical feeding or sludge pumping often have a built-in way to control either the length or timing of pumping strokes. Adjustments to these types of pumps are easy and quick. An adjustable timer can be used to control the percent of time the pump operates.

Energy savings can also be accomplished by sharing the pumping load among several pumps in a system. Use only the number of pumps necessary to handle the required volume at any time (44).

Pump Maintenance and Operation

Besides the adjustments to pumps discussed above, operation and maintenance can also affect energy consumption. Some items to regularly check are:

- Partial clogging or closures in valves, pipelines and pumps.
- Wear on pump impellers and casings which lowers effciency. Installation or replacement of wear rings or adjustment of the impeller setting is all that may be required to regain original efficiencies.
- Improper adjustment of packing causing binding of pump shaft.
- Improper settings for start-stop controls causing too frequent cycling of pumps.
- Dirty or loose electrical contacts.

Plant Lighting, Heating, and Ventilation

Past practice in many multi-shift plants has been to have all lights burning continuously regardless of the needs of the area. Non-work areas and yards are often highly illuminated. The electricity required for lighting in many plants could be reduced 20 to 30 percent without any loss in work efficiency or safety.

Your ventilation equipment may provide 4 to 6 fresh air changes per hour. Most industrial plants are designed for 1.5 fresh air changes per hour. If possible, the number of fresh air changes should be reduced for structures such as headworks, solids processing, tunnels, and digester control rooms; however, care must be taken to keep a safe working atmosphere in the various buildings. When ventilation rates can be safely reduced to 2 to 3 changes per hour, the building heat requirement may be reduced 25 to 30 percent.

Some energy conservation measures that are applicable to all large buildings are (7):

- Reduce corridor, room, and outdoor lighting levels as much as possible considering operational requirements, safety, and security.

- Shut down air conditioning equipment and reduce heating levels in unoccupied buildings as much as possible on weekends and holidays.

- Reduce the normal heating and cooling to unoccupied spaces such as storerooms.

- Reduce the amount of outside ventilation air used in heating, ventilating, and air conditioning systems to meet the minimum safe ventilation requirements.

- For predicted hot days, consider cooling the building below normal at night and during early morning hours and allowing the temprature to rise during the afternoon.

- Keep air filter systems clean for better circulation and to reduce fan horsepower.

- Inspect and repair, if necessary, insulation, caulking, weather-stripping, and storm windows of buildings.

- Check pipe insulation on all steam or hot water lines passing through air conditioned spaces and on all chilled water lines or cold air ducts passing through non-air-conditioned space.

- Regularly clean lighting fixtures, lamps, reflectors, and shades to keep up maximum lighting efficiency.

- Post instructions concerning operation and maintenance procedures for all employees.

- Turn off air conditioning shortly before the end of the working day in areas not used around-the-clock.

- For individual air conditioning units, close the damper admitting outside air to the minimum position.

- To reduce air conditioning loads, close blinds, shades, and draperies on the sunny side of the building.

- Keep outside doors and windows closed during heating and cooling seasons.

- Use a minimum amount of lighting during daylight hours in rooms which have adequate windows or skylights.

- Keep unnecessary lights turned off and shut off lights when leaving office or other work areas.

- Turn off electric fans, coffee makers, and other appliances when not needed, especially during peak demand periods.

Screening and Grit Removal

If you have a sludge incinerator, consider burning your screenings rather than hauling them to land disposal. If you do haul them, provide enough storage so that you don't waste any trips.

For grit removal, don't make any extra effort to produce a "clean" grit, which is later disposed of at a landfill. Washing grit may often be unnecessary.

Sludge Pumping

Over-pumping of sludge from settling basins wastes energy. Over-pumping often occurs during low-flow periods and results in sludge which is too thin. Pumps should be reset to reflect the low flow.

In addition to increasing the energy required to pump the sludge, there can be a chain effect throughout the plant. For example, the effects of pumping sludge with 4 percent solids versus 5 percent solids include: an increase of 20 to 25 percent in initial pumping energy; increased volume of sludge can affect loadings, efficiencies and energy requirements for thickeners, supernatant return pumps, chemical feeding and mixing equipment, digester heating systems and dewatering systems; and adverse effects on digester gas production and incinerator operation.

Trickling Filters

The major energy consumption in trickling filter operation is the electricity required for recirculation pumping. Attention to pump and motor efficiencies is important. The actual effect of increasing and decreasing recirculation rates should be determined at each plant. Plants which meet effluent discharge requirements at 1:1 recirculation ratios may also do so at 0.75:1 or 0.5:1 ratios (7).

Rotating Biological Contactors (RBC)

Energy consumption is largely for media rotation. If an RBC plant is operating at less than full design capacity, energy can be saved by leaving a portion of the contactor units idle, or by reducing the rotational speed. Adjusting rotational speed of individual stages to meet the discharge requirements should be done at each plant (7).

Activated Sludge

Energy required for aeration in an activated sludge plant usually exceeds all other uses in the plant. Because of this, the possibility of energy savings deserves a great deal of attention.

In diffused-air plants, the major energy user is the blower. Like pumps, blowers can be either centrifugal or positive displacement. Centrifugal blowers are most commonly used in large plants but are also used in small plants.

Centrifugal blowers can be controlled in much the same way as centrifugal pumps. Air flow can be controlled by partial closure of a throttling valve on the blower suction or discharge, by changing impeller design, or by changing speed. One of the easiest, most efficient ways is to adjust the valve on the suction side of the blower. This method reduces energy consumption more than throttling the discharge valve for the same reduction in air flow. Because most blower installations already have the necessary valving, the only cost is for operating labor. Control of the suction valve can also be made automatic. Seek help from your consulting engineer to do this; he will be aware of some of the problems associated with this, such as blower surge and its control.

Air flow and energy consumption can be controlled for positive displacement blowers by control of speed or the use of several units. You must also consider the side effects of reducing aeration. It could result in loss of treatment efficiency and in higher total plant energy uses as a result of an increased loading on solids processing. Thus, the overall effects of unit energy conservation on the total activated sludge process must be considered.

Proper maintenance of blower bearings, seals, and clearances can reduce energy use. Air filters and diffusers must be kept clean. If left dirty they can account for increased pressure drops of up to 20 percent (44).

Effects of Solids Retention Time on Overall Energy Utilization

Conserving electrical energy use by manipulating the solids retention time (SRT) results in a tradeoff between aeration basin power and additional sludge production. The higher the SRT, the larger the aeration energy requirement. The tradeoff is that sludge production decreases as the SRT increases. So at a higher SRT, the aeration energy requirements are higher, but the sludge treatment energy requirements are lower.

The practical limits of SRT vary from 3 days to about 15 days. By varying the SRT, the energy requirements may vary more than 20 percent. Overall, a lower SRT should reduce the overall energy requirements if the sludge handling system is a low energy use system. However, if the sludge produced is treated in an energy-intensive system, it may be more energy efficient to increase the SRT to reduce solids production (44).

Sludge Dewatering

Intermittent operation of sludge dewatering processes can save energy because equipment operated near design capacity has greater efficiency. If your plant is not yet fully loaded, operating intermittently at full load uses less energy than running all the time at low loadings.

The following example of a dewatering system consisting of chemical conditioning and vacuum filtration shows the potential for energy savings. Table 12 shows the energy requirements for 1 and 10 mgd plants operated intermittently and continuously. Intermittent operation could reduce energy consumption by approximately 45 percent for a 1 mgd plant and by over 20 percent for a 10 mgd plant. As the size of the plant increases, the saving continues to decrease, but at 100 mgd the saving is still about 15 percent. The total operating and maintenance costs would also be reduced through intermittent operation. The savings are approximately 20 percent for both 1 and 10 mgd plants (44).

TABLE 12. ENERGY REQUIREMENTS FOR CONTINUOUS AND INTERMITTENT OPERATION OF A VACUUM FILTER SYSTEM*

	Energy required, kwh/yr			
Treatment plant size	1 mgd		10 mgd	
Operation	Continuous	Intermittent**	Continuous	Intermittent
Vacuum Filtration	32,000	17,400	145,000	108,300
Chemical Conditioning	2,800	1,200	7,800	5,200
Storage	---	500	800	4,200
TOTAL	34,800	19,100	153,600	117,700

* Based on treatment of digester primary and waste activated sludge.
** Intermittent operation is for five, 8-hour shifts per week.

Source: Reference 44

Anaerobic Digestion

The digester heating requirements can be reduced by increasing the solids concentration in the sludge pumped to the digester. In some cases, the operating temperature in a lightly loaded digester may also be lowered without hurting the performance of the digester.

RESOURCE RECOVERY PROGRAMS

Use of Anaerobic Digester Gas

One of the best ways to reduce energy used in wastewater treatment is to recover and reuse the energy available in sludge digesters. Digester gas can be used for on-site generation of electricity or for digester and building heating. Digester gas can also be used off-site in a natural gas supply system. This will require treating the gas to remove hydrogen sulfide and moisture. Also, in most cases, the heat value of the digester gas must be increased by removing carbon dioxide before it is used in a natural gas system. It is very common for digester gas to be used for digester and building heating and on-site to generate electricity and drive pumps.

Gas Production

Gas produced by anaerobic digestion is about two-thirds methane and one-third carbon dioxide with relatively small amounts of water, hydrogen sulfide, ammonia, and other gases. The heat value of the gas varies from one plant to another, but is typically about 600 Btu/standard cubic foot (scf). In some installations the gas is used directly from the digester. In others, water and hydrogen sulfide are removed to protect engines and other equipment.

The volume of gas produced in the digester is usually at least 15 scf gas produced/lb volatile solids (VS) destroyed. For a typical activated sludge plant, this means about 11,000 scf of digester gas will be produced per million gallons treated. The heat value of this gas may be high enough to supply about 75 percent of the electrical power needed in the typical activated sludge plant.

Systems to Use Gas

A system to use anaerobic digester gas is shown in Figure 28. Gas from the digester is cleaned, compressed, and stored. After storage, the gas can be used directly as fuel to heat the digesters or buildings or as fuel for an internal combustion (IC) engine coupled to an electric generator. The IC engine could be used to generate electricity for general uses or directly coupled to an air blower or water pump to supply some of the aeration or pumping requirements. The engines can be equipped with heat recovery systems and the recovered heat used for building or digester heating. Such systems have been used for over 20 years in several treatment plants in the United States and other countries (45). Your consulting engineer can advise you if such a system might be economical in your plant.

Sludge Utilization

The use of sludge as fertilizer or soil conditioner saves energy two ways; it can eliminate energy used by some processes such as dewatering and incineration, and it reduces the need for energy to manufacture chemical fertilizers.

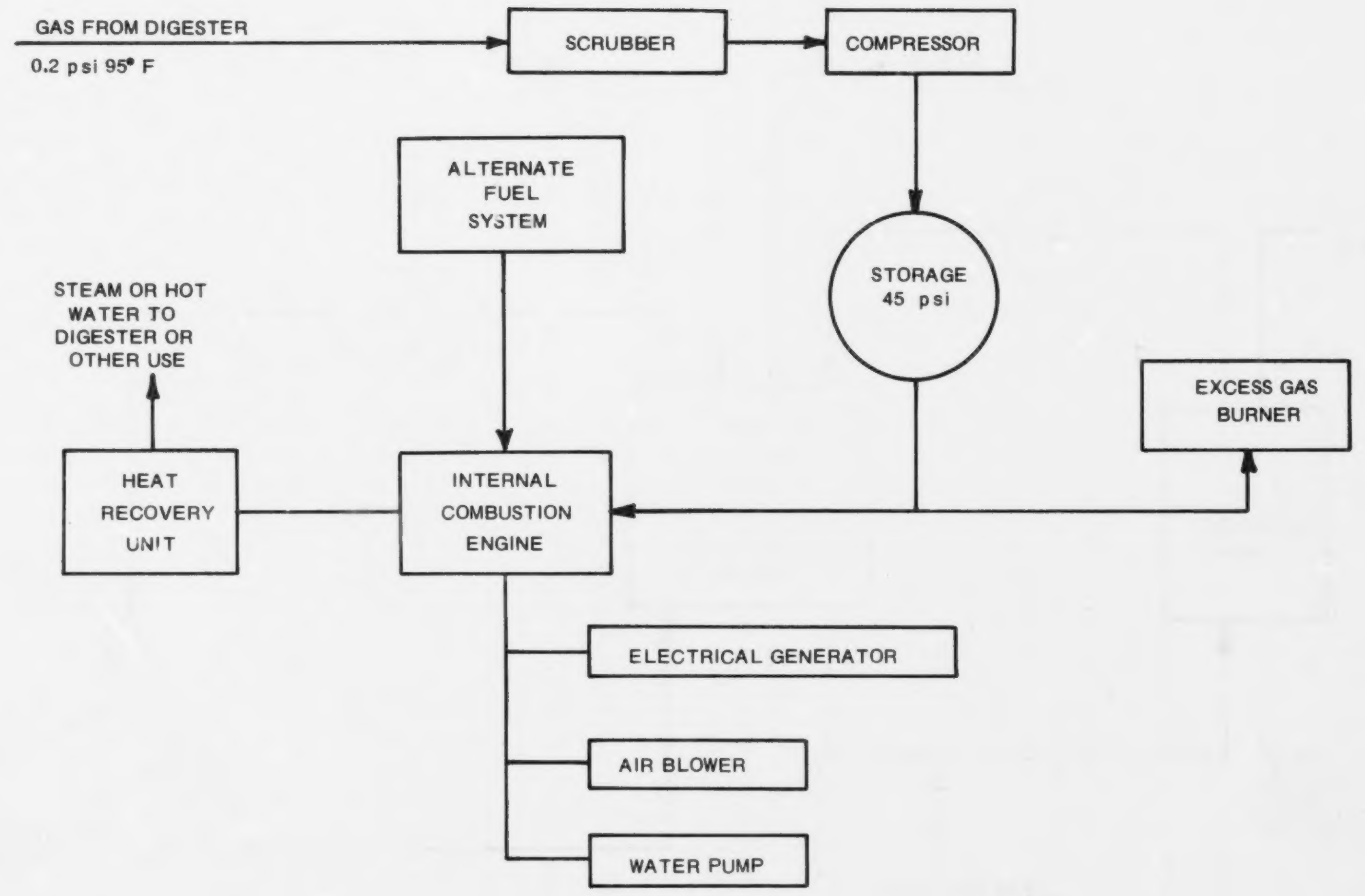
Using sludge on pasture and farm land is simple and relatively low in cost. Land application has been used to reclaim strip mine spoils or other poor land. Composted sludge is a good soil conditioner.

There are many local, state, inter-state and federal regulations on the use of sludge. Information on these rules can be obtained from the wastewater or solid waste agencies in your area and the local or state public health departments. These agencies are concerned about ground and surface water pollution from infiltration and runoff of sludge contaminants. This potential can be kept to a minimum with proper design, site selection, and operation, and depends upon soil type, climate, type of crop, application technique, and whether the sludge is liquid, dewatered, or dry.

If you dry digested sludge on sand beds, you should let the public know it is available for private use. With good publicity, some towns get rid of all their dried sludge this way. The most successful programs give the sludge away and have suggestions on how to best use it.

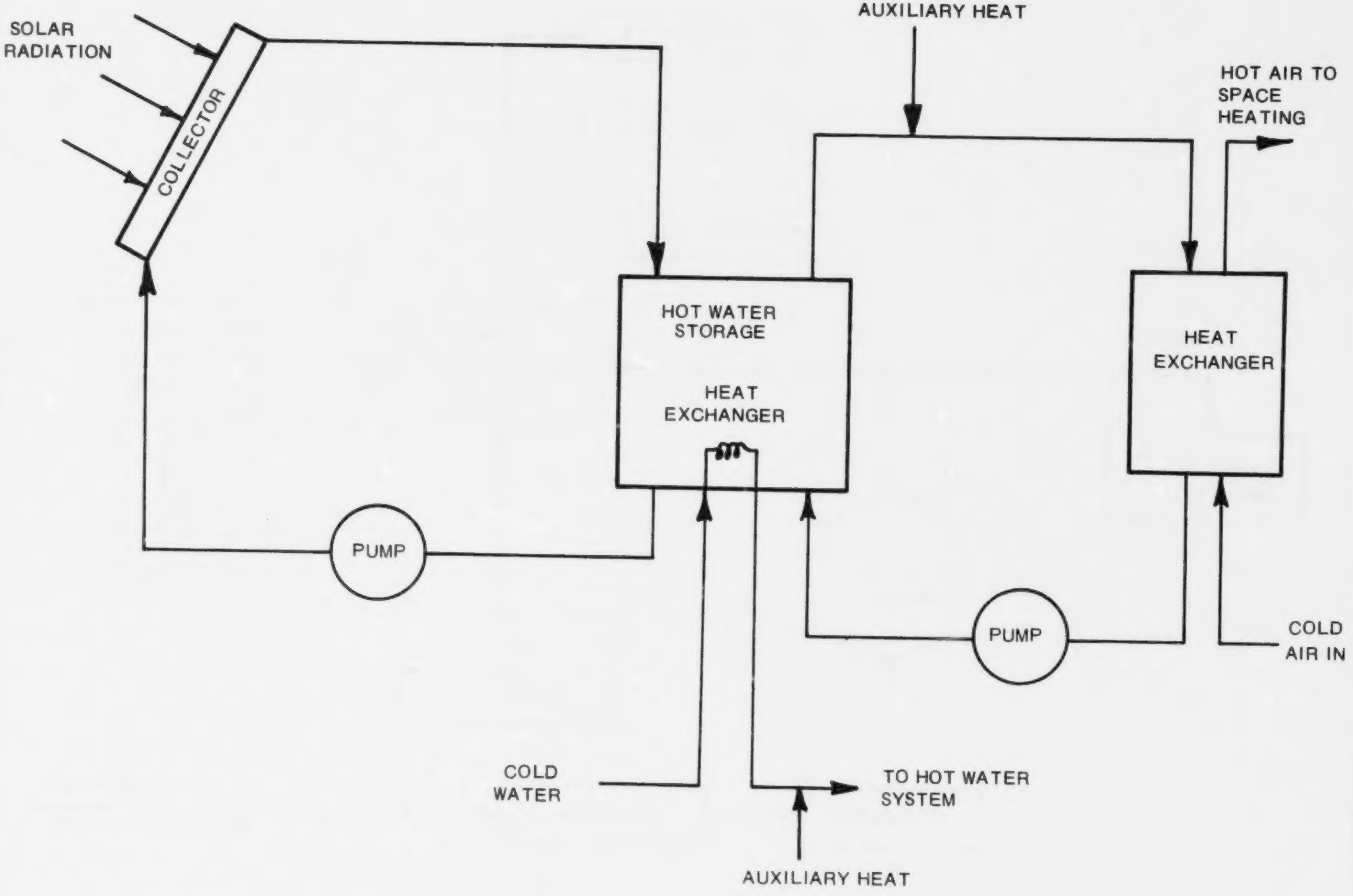
SOLAR ENERGY

There has been a great deal of publicity about solar heating. It may be useful in your plant for digester hot water or building heating. A system for hot water and space heating is shown in Figure 29. Solar energy has been proposed for use in digester heating, but no full scale plants use such a system at present. One study found (46):


GAS FROM DIGESTER
0.2 psi 95° F
SCRUBBER
COMPRESSOR
ALTERNATE FUEL SYSTEM
STORAGE 45 psi
STEAM OR HOT WATER TO DIGESTER OR OTHER USE
EXCESS GAS BURNER
HEAT RECOVERY UNIT
INTERNAL COMBUSTION ENGINE
ELECTRICAL GENERATOR
AIR BLOWER
WATER PUMP

Source: Reference 45

Figure 28. Anaerobic digester gas utilization system.


SOLAR RADIATION
COLLECTOR
AUXILIARY HEAT
HOT AIR TO SPACE HEATING
HOT WATER STORAGE
HEAT EXCHANGER
HEAT EXCHANGER
PUMP
PUMP
COLD AIR IN
COLD WATER
TO HOT WATER SYSTEM
AUXILIARY HEAT

Source: Reference 45

Figure 29. Solar energy system for water and space heating.

- It is technically and economically feasible to heat digesters with solar energy.

- The lowest cost method is to supply about 90 percent of the annual digester heat requirement with solar energy.

- Preheating raw sludge before it enters the digester is the best method of using solar energy.

- Solar heating of anaerobic digesters is economically feasible at all locations in the United States, including Alaska.

- The best size solar heating system would supply 82 to 97 percent of the annual heat requirement.

Your consulting engineer can advise you if solar heat would be economically attractive at your plant.

MANAGEMENT OF OPERATIONS

Your main responsibility in management of energy conservation efforts is to ensure that they do not reduce plant effluent quality or performance of solids handling systems. You should:

- Be aware of changes in the availability of critical supplies.

- Keep operating records for all electrical power, fuel and chemical uses for the entire plant and for individual unit processes, where possible.

- Develop a contingency plan for operating the plant at various levels of reduced electrical power, fuels, and chemicals in case shortages occur.

- Explore the possibility of making fuel or chemical substitutions in case of prolonged shortages.

- Provide training on energy aspects so that your operators can carry out energy conservation practices.

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APPENDICES

APPENDIX A

EXAMPLE ALLOCATION OF COSTS

Basic data:

Design plant flow = 5 mgd; design sewer system flow = 10 mgd

Population served = 30,000

		mg/l		lbs/day	
	Volume, mgd	BOD	SS	BOD	SS
Flows:					
Wastewater (non-industrial)	3.25	300	350	8,130	9,500
Industrial	0.75	750	450	4,690	2,800
Infiltration	0.50	-	-	-	-
	4.50				

Assessed valuation:

Community	$80,000,000
Industry	4,000,000

Design loadings:

BOD	16,500 lbs
SS	15,500 lbs

Construction Costs

Collection System	$2,000,000
Treatment Plant	
Primary Sedimentation Tanks	260,000
Aeration Basins	360,000
Aeration Equipment	230,000
Secondary Sedimentation Tanks	330,000
Return Activated Sludge Pumping Station	160,000
Waste Activated Sludge Pumping Station	170,000

Primary Sludge Pumping Station	93,000
Chlorine Contact Basins	140,000
Chlorination Equipment	37,000
Gravity Thickener	72,000
Dissolved Air Flotation Thickener	180,000
Vacuum Filter	250,000
Polymer Feed and Storage	50,000
Incineration	1,900,000
Subtotal	$4,232,000
Yardwork	592,000
TOTAL CONSTRUCTION COST	$4,824,000
Engineering, Fiscal, Legal	579,000
Interest During Construction	482,000
TOTAL CAPITAL COSTS	$5,885,000

Operating Costs (Annual)

	Labor	Power & Fuel	Maintenance Materials	Chemicals
Plant				
Primary Sedimentation	$10,800	$ 65	$1,600	-
Aeration Equipment	24,300	22,000	6,400	-
Secondary Sedimentation	12,600	65	2,000	-
Return Activated Sludge Pumping	8,370	840	840	-
Waste Activated Sludge Pumping	1,900	90	4,000	-

Operating Costs (Annual) (Continued)

	Labor	Power & Fuel	Maintenance Materials	Chemicals
Plant				
Primary Sludge Pumping	1,200	30	1,900	-
Chlorination Equipment	10,400	-	2,500	16,700
Gravity Thickener	3,600	30	130	-
Dissolved Air Flotation Thickener	6,900	3,800	120	400
Vacuum Filter	22,500	2,400	17,000	64,400
Polymer Feed and Storage	2,800	40	50	-
Incineration	44,100	38,000	6,800	-
Collection System	6,000	-	4,000	-
	$155,470	$67,360	$47,340	$81,000

Allocate Collection System Costs

The capital costs can be allocated as follows:

	Design Flow, mgd	Allocation
Total System	10.00	
Current Domestic Users	3.25	32.5%
Industry	0.75	7.5%
Infiltration	0.50	5.0%
Future Use	5.50	55.0%

The costs for future use (55%) should be recovered through property taxes while the costs for current use (45%) would be recovered from service charges. In terms of annual revenue:

Annual debt service and coverage on local capital cost of $2,000,000 for collection system	= $226,540
Required revenue from property taxes (55%)	= 124,600
Required revenue from user charges (45%)	= 101,940

The operating costs for the collection system are primarily related to flow.

Annual O&M costs for collection system from current users = $10,000

Allocate Treatment Plant Costs

A fair allocation of treatment plant costs is more complex because the costs of some treatment units are primarily determined by flow, some by BOD, and some by suspended solids. The costs can be categorized by treatment process as follows:

	Total Capital*	Local Annual** Capital	Annual O&M
Primarily Affected By Flow:			
Primary Sedimentation	$ 361,400		$12,465
Secondary Sedimentation	458,700		14,665
Activated Sludge Pumping	458,700		16,040
Chlorination	246,000		29,600
	$1,524,800	$43,200	$72,770
Primarily Affected by SS:			
Primary Sludge Pumping	129,300		3,130
Thickeners	350,300		14,580
Vacuum Filter	347,500		106,300
Polymer System	69,500		2,890
Incineration	2,641,000		88,900
	$3,537,600	$100,175	$215,800

	Total Capital*	Local Annual** Capital	Annual O&M
Primarily Affected By BOD:			
Aeration Basins	$ 502,900		-
Aeration Equipment	319,700		52,700
	$ 822,600	$ 23,265	$ 52,700
TOTAL	$5,885,000	$166,640	$341,270

*Including allowance for yardwork, engineering, fiscal, legal, interest, etc. requirements of 20%

**Reflects 75% grant funding, and debt coverage

The first step is to allocate these costs between present and future design loads for each category of costs:

Flow related costs:

$$\frac{\text{Current flows}}{\text{Design flows}} = \frac{4.50}{5.00} = \text{90\% to current users}$$

BOD related costs:

$$\frac{\text{Current load}}{\text{Design load}} = \frac{12,820}{16,500} = \text{78\% to current users}$$

SS related costs:

$$\frac{\text{Current load}}{\text{Design load}} = \frac{12,300}{15,500} = \text{79\% to current users}$$

Capital costs from current users would be recovered through user charges while costs for future users would be recovered from property taxes:

	Local Capital Costs	From Current Users	From Future Users
Flow Related	$ 43,200	$ 38,900	$ 4,300
BOD Related	23,265	18,150	5,115
SS Related	100,175	79,140	21,035
TOTAL	$166,640	$136,190	$30,450

Plant O&M costs are recovered from current users.

	O&M Costs
Flow Related	$ 72,770
BOD Related	52,700
SS Related	215,800
TOTAL	$341,270

In addition, the reserve fund contribution of $25,000 per year must be allocated. This requires a judgment as to fair distribution between current and future users for each system. In this case, 75 percent of the reserve fund is estimated to be for the benefit of current users.

	From Current Users	From Current & Future Users
Collection System		
Capital	$124,600	$101,940
O&M	10,000	-
Treatment Plant		
Capital	136,190	30,450
O&M	341,270	-
Reserve Fund	18,750	6,250
TOTAL	$630,810	$138,640

User Charges

The revenue to be generated from property taxes for benefits which are realized by present and future users was $138,640. Based on the total assessed valuation of $84,000,000, this would require a property tax of $1.65 per $1,000 of assessed valuation.

The bulk of the revenue ($630,810) is to be raised through charges to the users who are currently realizing benefits from the system. One approach is based on the allocation of costs to BOD, SS, and flow as calculated earlier:

	Costs Allocated	Quantity	Cost
Flow (4.0 mil gal domestic & industrial)		1,460 MG	$0.182/1,000 gal
Sewers	$134,600		
Treatment	111,670		
Reserve Fund	18,750		
BOD	70,850	4,679,300 lb	$15.14/1,000 lb
Suspended Solids	294,940	4,489,500 lb	$65.70/1,000 lb
	$630,810		

The cost for domestic users per 1,000 gal is then:

Flow related	$0.1820/1,000 gal
BOD related @ 300 mg/1, 25 lb/1,000 gal	0.0379/1,000 gal
SS related @ 350 mg/1, 29 lb/1,000 gal	0.1906/1,000 gal
TOTAL	$0.410/ 1,000 gal

The charge to the industrial user would be:

Flow related	$0.179/1,000 gal
BOD related @ 750 mg/1, 6.25 lb/1,000 gal	0.095/1,000 gal
SS related @ 450 mg/1, 3.75 lb/1,000 gal	0.246/1,000 gal
TOTAL	$0.520/1,000 gal

The total annual revenues would then be:

Domestic User Charges $410/mil gal x 3.25 mgd x 365 =	$486,360
Industrial User Charges $520/mil gal x 0.75 mgd x 365 =	142,350
Property Taxes	138,640
TOTAL	$767,350

APPENDIX B

EXAMPLE STAFFING CALCULATIONS

EXAMPLE DETERMINATIONS OF STAFFING

To supplement the staffing estimation procedures outlined in Section 7, several examples are presented. The information used in the examples was derived from EPA reports (20, 47, 48). The treatment plants included are used only as examples to show the staffing selection procedure.

The level of utilization of plant personnel was assumed to be 1,656 hours/year, from Table 1, and the job descriptions in Section 7 were used to specify job titles. Each of the examples is described briefly in the following paragraphs. For these examples, the curves used don't separate operation and maintenance labor requirements. Thus, judgment was used in classifying the labor between operation and maintenance.

Example No. 1 - This example is based on a 1 mgd capacity oxidation ditch extended aeration plant. The plant doesn't have much mechanical equipment, therefore the maintenance requirements are not great. The operational requirements are estimated to be 70 percent of the total operation and maintenance man-hours. The annual labor requirement is shown in Table B-1 and required staff in Table B-2. An organizational chart is included to show how the staffing could be set up, as seen in Figure B-1.

Example No. 2 - The plant is a conventional 1 mgd activated sludge plant using submerged aeration. The plant is more difficult to operate than an extended aeration plant and includes more mechanical equipment which requires more maintenance. An operation to maintenance ratio of 0.65 to 0.35 was used. The resulting labor requirments, job classifications, and organization chart are shown in Tables B-3 and B-4 and Figure B-2, respectively.

Example No. 3 - The third plant is a 1 mgd rock media trickling filter plant. The plant is simple to operate and does not contain complex machinery. Operation requires more labor than maintenance. The annual labor requirements, the job classifications, and an organizational chart are shown in Tables B-5 and B-6 and Figure B-3.

TABLE B-1. EXAMPLE NO. 1 - OXIDATION DITCH
(1 mgd average day flow)

Functional Unit	Unit Parameter	Quantity	Labor, hr/yr
Raw sewage pumping	Capacity/flow, mgd	3.5/1.0	1,050
Preliminary treatment	Flow, mgd	1.0	900
Aeration	Horsepower	60	1,700
Final sedimentation	Area, sq ft	2,916	800
Return sludge pumping	Capacity/flow, gpm	500/250	300
Waste sludge pumping	Capacity, flow, gpm	25/11	85
Chlorination	Tons/yr	7.7	450
Sludge drying beds	Tons/yr	168	200
Sludge hauling	Volume, cu yd/yr, 10 mi	670	90
Administrative	Capacity, mgd	1.0	500
Laboratory	# samples*/day	2	
	# days/yr	100	500
Site work	Site area, sq ft	200,000	1,700
TOTAL			8,275

* Samples of influent, effluent, oxidation ditch, and sludge hauled

TABLE B-2. EXAMPLE NO. 1 - 1 MGD OXIDATION DITCH

Estimated plant staffing complement

Project Example #1: 1 mgd Oxidation Ditch
Computed by RBW
Date 11/22/78

Staff position	Estimated annual payroll requirements		Suggested staffing
	Man hours	Number of employees*	Number of employees
Administration & General:			
Superintendent			
Assistant Superintendent			
Clerk Typist			
Storekeeper			
Subtotal	500	0.3	
Operation Labor:			
Operations Supervisor			
Shift Foreman			
Operator II			1
Operator I			1.5
Automotive Equipment Operator			
Subtotal	3,902	2.4	
Maintenance Labor:			
Maintenance Supervisor			
Mechanical Maintenance Foreman			
Maintenance Mechanic II			
Maintenance Mechanic I			
Electrician II			
Electrician I			
Painter			
Maintenance Helper			1
Subtotal	1,673	1.0	
Laboratory:			
Chemist			
Laboratory Technician			0.5
Subtotal	500	0.3	
Site Work:			
Laborer			1
Custodian			
Subtotal	1,700	1.0	
Total Labor Requirements	8,275	5.0	5

* Man-hours divided by level of utilization (1656 hrs/yr)

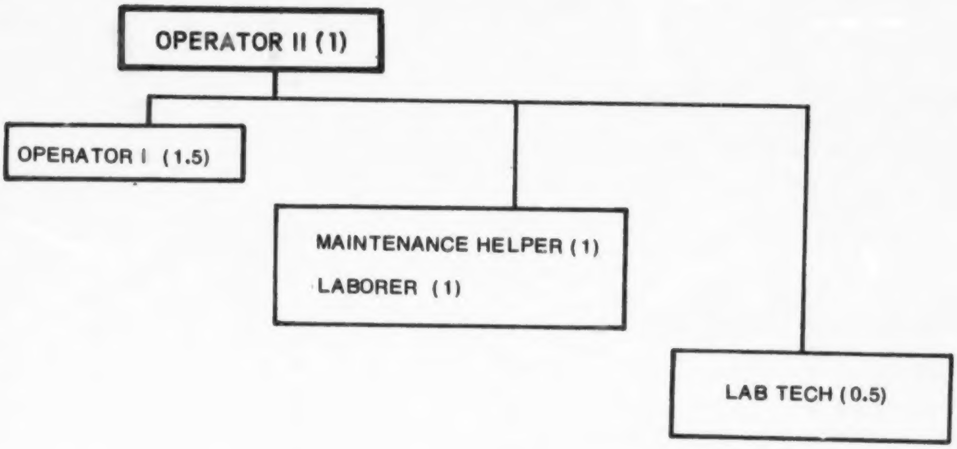
OPERATOR II (1)
OPERATOR I (1.5)
MAINTENANCE HELPER (1)
LABORER (1)
LAB TECH (0.5)

Figure B-1. Example No. 1 - organization chart.

TABLE B-3. EXAMPLE NO. 2 - 1 MGD CONVENTIONAL ACTIVATED SLUDGE PLANT

Functional Unit	Unit parameter	Quantity	Labor, hr/yr
Raw sewage pumping	Capacity/flow, mgd	3.5/1.0	1,050
Preliminary treatment	Flow, mgd	1.0	900
Primary sedimentation	Area, sq ft	1,607	630
Raw sludge pumping	Capacity, gpm	50	120
Aeration	Horsepower	50	1,550
Final sedimentation	Area, sq ft	2,916	800
Return sludge pumping	Capacity/flow, gpm	500/250	300
Waste sludge pumping	Capacity, flow, gpm	25	85
Chlorination	Tons/yr	7.7	450
Anaerobic digester	Volume, cu ft	48,000	1,400
Sludge drying beds	Tons/yr	125	190
Sludge hauling	Cu yd/yr,	500	80
Administrative	Capacity, mgd	1	500
Laboratory	# samples*/day	2	
	# days/yr	100	600
Site work	Site area, sq ft	200,000	1,700
TOTAL			10,155

* Samples of influent, effluent, return activated sludge, digester contents

TABLE B-4. EXAMPLE NO. 2 - 1 MGD CONVENTIONAL ACTIVATED SLUDGE PLANT

Estimated plant staffing complement

Project Example #2: 1 mgd Activated Sludge Plant Computed by RBW Date 11/22/78

Staff position	Estimated annual payroll requirements: Man hours	Estimated annual payroll requirements: Number of employees*	Suggested staffing: Number of employees
Administration & General:			
Superintendent			
Assistant Superintendent			
Clerk Typist			
Storekeeper			
Subtotal	500	0.3	
Operation Labor:			
Operations Supervisor			
Shift Foreman			
Operator II			1
Operator I			1.5
Automotive Equipment Operator			0.5
Subtotal	4,910	3.0	
Maintenance Labor:			
Maintenance Supervisor			
Mechanical Maintenance Foreman			
Maintenance Mechanic II			
Maintenance Mechanic I			1
Electrician II			
Electrician I			
Painter			
Maintenance Helper			0.5
Subtotal	2,645	1.6	
Laboratory:			
Chemist			
Laboratory Technician			0.5
Subtotal	600	0.4	
Site Work:			
Laborer			1
Custodian			
Subtotal	1,700	1.0	
Total Labor Requirements	10,355	6.3	6

* Man-hours divided by level of utilization (1656 hrs/yr)

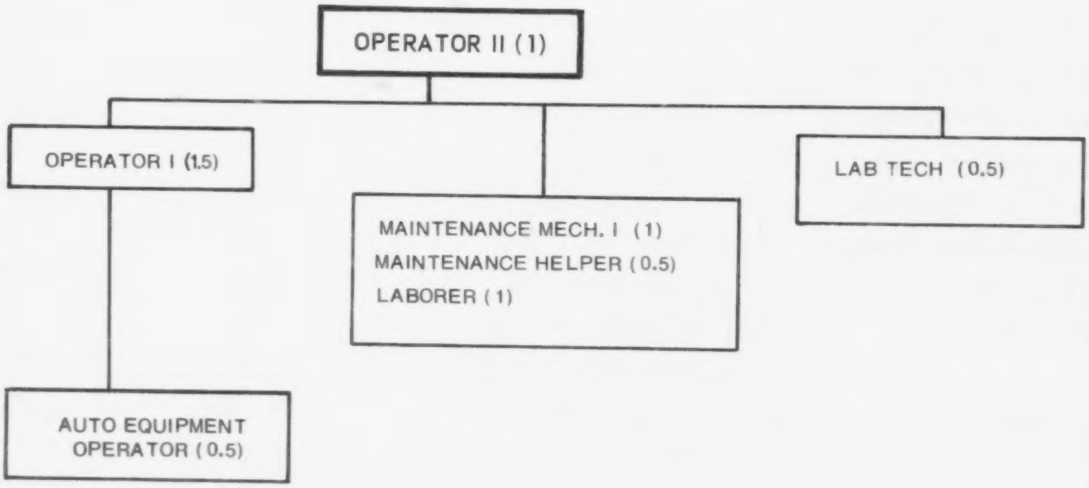
OPERATOR II (1)
OPERATOR I (1.5)
LAB TECH (0.5)
MAINTENANCE MECH. I (1)
MAINTENANCE HELPER (0.5)
LABORER (1)
AUTO EQUIPMENT OPERATOR (0.5)

Figure B-2. Example No. 2 - organization chart.

TABLE B-5. EXAMPLE NO. 3 - 1 MGD, 21-FT FABRICATED MEDIA TRICKLING FILTER PLANT

Functional Unit	Unit Parameter	Quantity	Labor, hr/yr
Raw sewage pumping	Capacity/flow, mgd	3.5/1.0	1,050
Aerated grit removal	Flow, mgd	1.0	900
Primary sedimentation	Area, sq ft	1,670	630
Raw sludge pumping	Capacity/flow, gpm	100	150
21' fabricated media TF	Volume, cu ft	103,600	450
Recycle pumping	Capacity/flow, mgd	5.5	1,050
Final sedimentation	Area, sq ft	1,820	660
Waste sludge pumping	Capacity flow, gpm	50	110
Chlorination	Tons/yr	7.7	450
Anaerobic digestion	Volume, cu ft	15,000	1,150
Sludge drying beds	Tons/yr	92	170
Administrative	Capacity, mgd	1.0	500
Laboratory	# samples*/day	2	
	# days/yr	100	600
Site work	Site area, sq ft	200,000	1,700
TOTAL			9,570

* Samples of influent, effluent, trickling filter influent and effluent, final effluent, digester.

TABLE B-6. EXAMPLE NO. 3 - 1 MGD, 21-FT FABRICATED MEDIA TRICKLING FILTER

Estimated plant staffing complement

Project Example #3: 1 mgd Fabricated Media Trickling Filter
Computed by RBW
Date 11/22/78

Staff position	Estimated annual payroll requirements		Suggested staffing
	Man hours	Number of employees*	Number of employees
Administration & General:			
Superintendent			
Assistant Superintendent			
Clerk Typist			
Storekeeper			
Subtotal	500	0.3	
Operation Labor:			
Operations Supervisor			
Shift Foreman			
Operator II			1
Operator I			2
Automotive Equipment Operator			
Subtotal	4,739	2.9	
Maintenance Labor:			
Maintenance Supervisor			
Mechanical Maintenance Foreman			
Maintenance Mechanic II			
Maintenance Mechanic I			
Electrician II			
Electrician I			
Painter			
Maintenance Helper			1
Subtotal	2,031	1.2	
Laboratory:			
Chemist			
Laboratory Technician			1
Subtotal	600	0.4	
Site Work:			
Laborer			1
Custodian			
Subtotal	1,700	1.0	
Total Labor Requirements	9,570	5.8	6

* Man-hours divided by level of utilization (1656 hrs/yr)

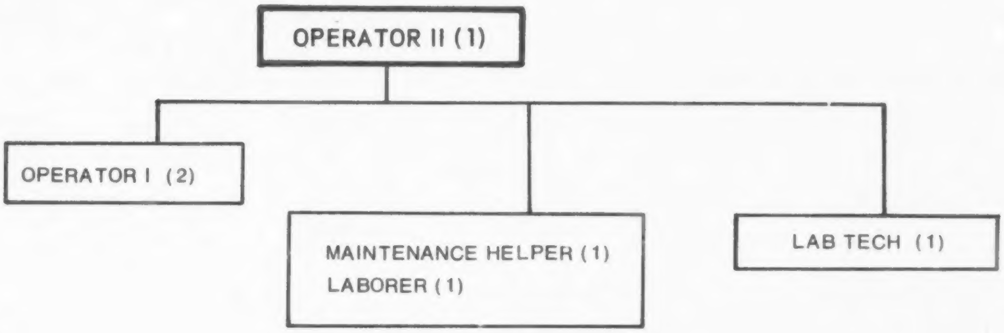
OPERATOR II (1)
OPERATOR I (2)
MAINTENANCE HELPER (1)
LABORER (1)
LAB TECH (1)

Figure B-3. Example No. 3 - organization chart.

Example No. 4 - The fourth plant is a 5 mgd rotating biological contactor plant. It is simple to operate and does not contain complex machinery. A 65 to 35 ratio was used to determine the breakdown between operation and maintenance personnel. The annual labor requirements and the job positions suggested are shown in Tables B-7 and B-8, and an organizational chart in Figure B-4.

Example No. 5 - This example is a 10 mgd rock media trickling filter plant. Operation is simple and there is no complex machinery. The annual labor requirements, a suggested staffing guide and an organizational chart are shown on Tables B-9 and B-10 and Figure B-5.

Example No. 6 - This plant is a standard 10 mgd air activated sludge plant including sludge digestion and dewatering. Operation is more complicated and the process is subject to upset. Maintenance is also more demanding due to the additional equipment required. Annual labor requirements and the suggested staffing level are as shown on Tables B-11 and B-12, and the organizational structure is shown in Figure B-6.

TABLE B-7. EXAMPLE NO. 4 - 5 MGD ROTATING BIOLOGICAL CONTACTOR

Unit	Unit Parameter	Quantity	Labor, hr/yr
Raw sewage pumping	Capacity/flow, mgd	13.5/5.0	1,300
Aerated grit removal	Flow, mgd	5.0	1,900
Primary sedimentation	Area, sq ft	8,330	1,400
Raw sludge pumping	Capacity/flow, gpm	80	140
Rotating media TF	Volume, cu ft	185,000	2,500
Final sedimentation	Area, sq ft	8,330	1,400
Waste sludge pumping	Capacity, flow, gpm	100	160
Chlorination	Tons/yr	40	780
Anaerobic digestion	Volume, cu ft	75,000	1,700
Sludge pumping	Capacity/flow, gpm	25	85
Vacuum filtration	Tons/yr,	506	
	Area, sq ft	400	1,700
Sludge hauling	Volume, cu yd/yr	2,044	380
Administrative	Capacity, mgd	5.0	1,600
Laboratory	# samples*/day	3	2,400
	# days/yr	300	
Site work	Site area, sq ft	300,000	2,100
TOTAL			19,545

* Samples of influent, effluent, trickling effluent, digester, vacuum filter

TABLE B-8. EXAMPLE NO. 4 - 5 MGD ROTATING BIOLOGICAL CONTRACTOR

Estimated plant staffing complement

Project Example #4: 5 mgd Rotating Biological Contactor
Computed by RBW
Date 11/22/78

Staff position	Estimated annual payroll requirements Man hours	 Number of employees*	Suggested staffing Number of employees
Administration & General:			
Superintendent			1
Assistant Superintendent			
Clerk Typist			
Storekeeper			
Subtotal	1,600	1.0	
Operation Labor:			
Operations Supervisor			
Shift Foreman			
Operator II			1
Operator I			3
Automotive Equipment Operator			1
Subtotal	8,739	5.3	
Maintenance Labor:			
Maintenance Supervisor			
Mechanical Maintenance Foreman			
Maintenance Mechanic II			
Maintenance Mechanic I			1
Electrician II			1
Electrician I			
Painter			
Maintenance Helper			1
Subtotal	4,706	2.8	
Laboratory:			
Chemist			
Laboratory Technician			1.5
Subtotal	2,400	1.5	
Site Work:			
Laborer			1
Custodian			0.5
Subtotal	2,100	1.3	
Total Labor Requirements	19,545	11.9	12

* Man-hours divided by level of utilization (1656 hrs/yr)

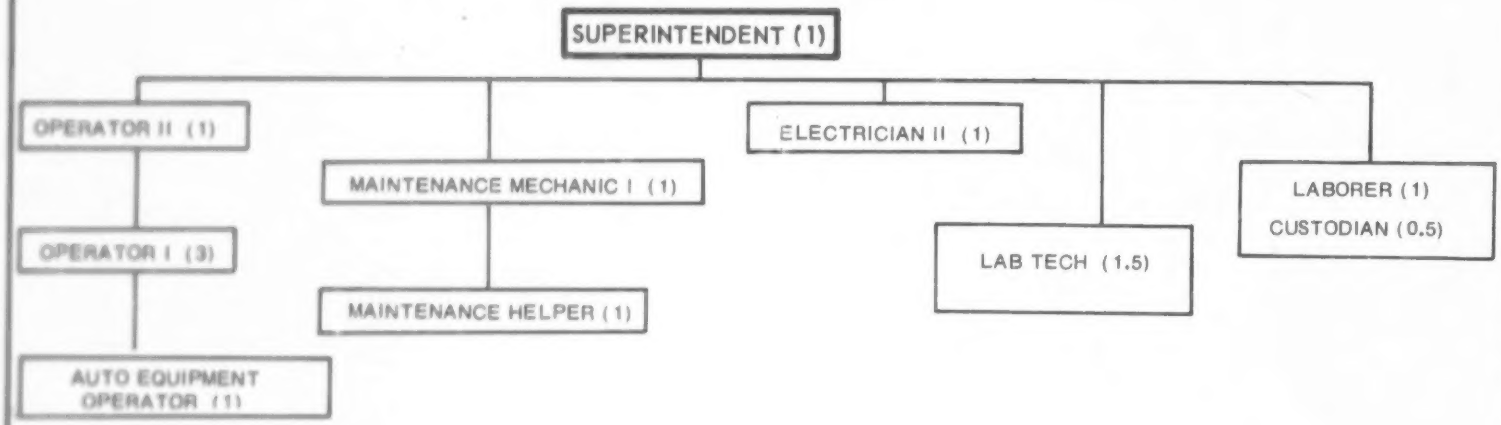
SUPERINTENDENT (1)
OPERATOR II (1)
OPERATOR I (3)
AUTO EQUIPMENT OPERATOR (1)
MAINTENANCE MECHANIC I (1)
MAINTENANCE HELPER (1)
ELECTRICIAN II (1)
LAB TECH (1.5)
LABORER (1)
CUSTODIAN (0.5)

Figure B-4. Example No. 4 - organization chart.

TABLE B-9. EXAMPLE NO. 5 - 10 MGD ROCK MEDIA TRICKLING FILTER

Unit	Unit Parameter	Quantity	Labor, hr/yr
Raw sewage pumping	Capacity/flow, mgd	25	1,700
Aerated grit removal	Flow, mgd	10	3,000
Primary sedimentation	Area, sq ft	16,700	2,100
Raw sludge pumping	Capacity/flow, gpm	100	160
8' rock media TF	Volume, cu ft	1,412,000	2,500
Recycle pumping	Capacity/flow, mgd	50/50	2,500
Final sedimentation	Area, sq ft	16,700	2,100
Waste sludge pumping	Capacity flow, gpm	150	160
Chlorination	Tons/yr	77	1,100
Anaerobic digestion	Volume, cf	150,000	2,200
Sludge pumping	Capacity/flow, gpm	50	110
Vacuum filtration	Tons/yr, area	1,012	
	Area, sq ft	200	2,600
Sludge hauling	Volume, cu yd/yr	4,088	500
Administrative	Capacity, mgd	10	3,000
Laboratory	# samples*/day	4	
	# days/yr	300	3,300
Site work	Site area, sq ft	300,000	2,800
TOTAL			29,830

* Samples of influent, trickling filter influent effluent, final effluent, digester, vacuum filter

TABLE B-10. EXAMPLE NO. 5 - 10 MGD ROCK MEDIA TRICKLING FILTER

Estimated plant staffing complement

Project Example #5: 10 mgd Rock Media Trickling Filter Computed by RBW Date 11/22/78

Staff position	Estimated annual payroll requirements		Suggested staffing
	Man hours	Number of employees*	Number of employees
Administration & General:			
Superintendent			1
Assistant Superintendent			
Clerk Typist			0.5
Storekeeper			0.5
Subtotal	3,000	1.8	
Operation Labor:			
Operations Supervisor			
Shift Foreman			3
Operator II			
Operator I			4
Automotive Equipment Operator			1
Subtotal	13,474	8.1	
Maintenance Labor:			
Maintenance Supervisor			
Mechanical Maintenance Foreman			
Maintenance Mechanic II			1
Maintenance Mechanic I			1.5
Electrician II			1
Electrician I			
Painter			
Maintenance Helper			1
Subtotal	7,246	4.4	
Laboratory:			
Chemist			1
Laboratory Technician			1
Subtotal	3,300	2.0	
Site Work:			
Laborer			1
Custodian			0.5
Subtotal	2,800	1.7	
Total Labor Requirements	29,830	18.0	18

* Man-hours divided by level of utilization (1656 hrs/yr)

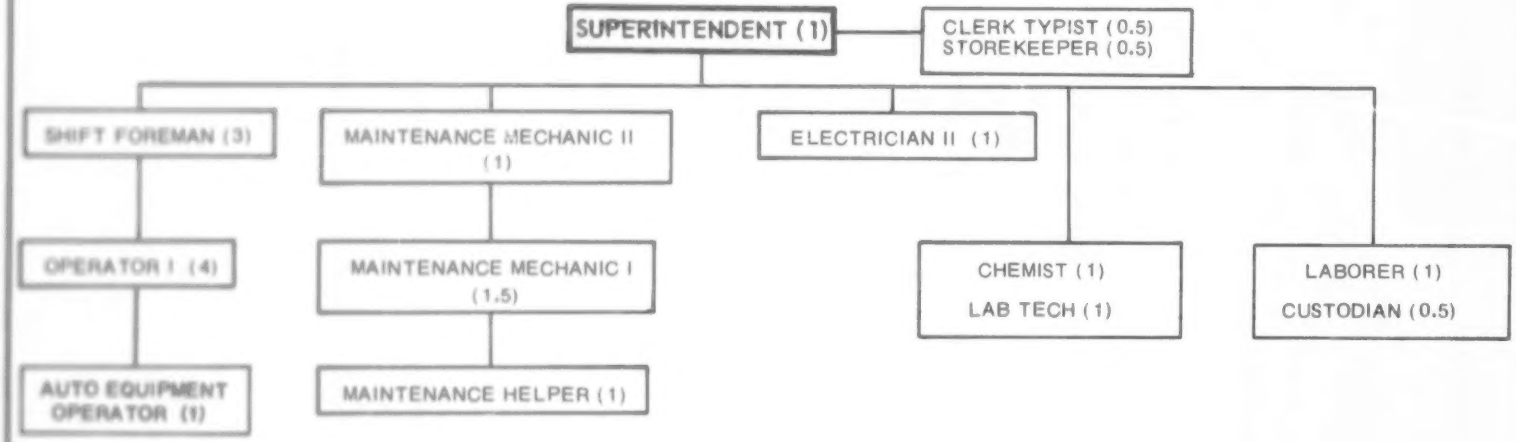
SUPERINTENDENT (1)
CLERK TYPIST (0.5)
STOREKEEPER (0.5)
SHIFT FOREMAN (3)
MAINTENANCE MECHANIC II (1)
ELECTRICIAN II (1)
OPERATOR I (4)
MAINTENANCE MECHANIC I (1.5)
CHEMIST (1)
LAB TECH (1)
LABORER (1)
CUSTODIAN (0.5)
AUTO EQUIPMENT OPERATOR (1)
MAINTENANCE HELPER (1)

Figure B-5. Example No. 5 - organization chart.

TABLE B-11. EXAMPLE NO. 6 - 10 MGD ACTIVATED SLUDGE PLANT

Unit	Unit Parameter	Quantity	Labor, hr/yr
Raw sewage pumping	Capacity/flow, mgd	25/10	1,700
Aerated grit removal	Flow, mgd	10	3,000
Primary sedimentation	Area, sq ft	16,700	2,100
Raw sludge pumping	Capacity/flow, gpm	50	120
Aeration, including aerobic digester	cfm	16,450	5,500
Return pumping	Capacity/flow, mgd	4,830/3,500	700
Final sedimentation	Area, sq ft	20,845	2,300
Waste sludge pumping	Capacity, gpm	240	200
Chlorination	Tons/yr	77	1,100
Anaerobic digestion	Volume, cu ft	130,000	2,000
Flotation thickener	Area, sq ft	110	500
Sludge holding tank	Volume, cu ft	37,000	1,200
Sludge pumping	Capacity/flow, gpm	40	100
Vacuum filtration	Tons/yr,	1,675	3,200
	Area, sq ft	153	
Administrative	Capacity, mgd	10	3,000
Laboratory	# samples*/day	4	
	# days/yr	300	3,300
Site work	Site area, sq ft	400,000	2,800
TOTAL			32,820

* Samples of influent, effluent, return activated sludge, digester, thickener, vacuum filters.

TABLE B-12. EXAMPLE NO. 6 - 10 MGD ACTIVATED SLUDGE PLANT

Estimated plant staffing complement

Project Example #6: 10 mgd Activated Sludge
Computed by RBW
Date 11/22/78

Staff position	Estimated annual payroll requirements		Suggested staffing
	Man hours	Number of employees*	Number of employees
Administration & General:			
Superintendent			1
Assistant Superintendent			
Clerk Typist			0.5
Storekeeper			0.5
Subtotal	3,000	1.8	
Operation Labor:			
Operations Supervisor			
Shift Foreman			3
Operator II			
Operator I			4.5
Automotive Equipment Operator			1
Subtotal	14,239	8.6	
Maintenance Labor:			
Maintenance Supervisor			
Mechanical Maintenance Foreman			1
Maintenance Mechanic II			
Maintenance Mechanic I			2
Electrician II			1
Electrician I			
Painter			
Maintenance Helper			2.0
Subtotal	9,493	5.7	
Laboratory:			
Chemist			1
Laboratory Technician			1
Subtotal	3,300	2.0	
Site Work:			
Laborer			1
Custodian			0.5
Subtotal	2,800	1.7	
Total Labor Requirements	32,832	19.8	20

* Man-hours divided by level of utilization (1656 hrs/yr)

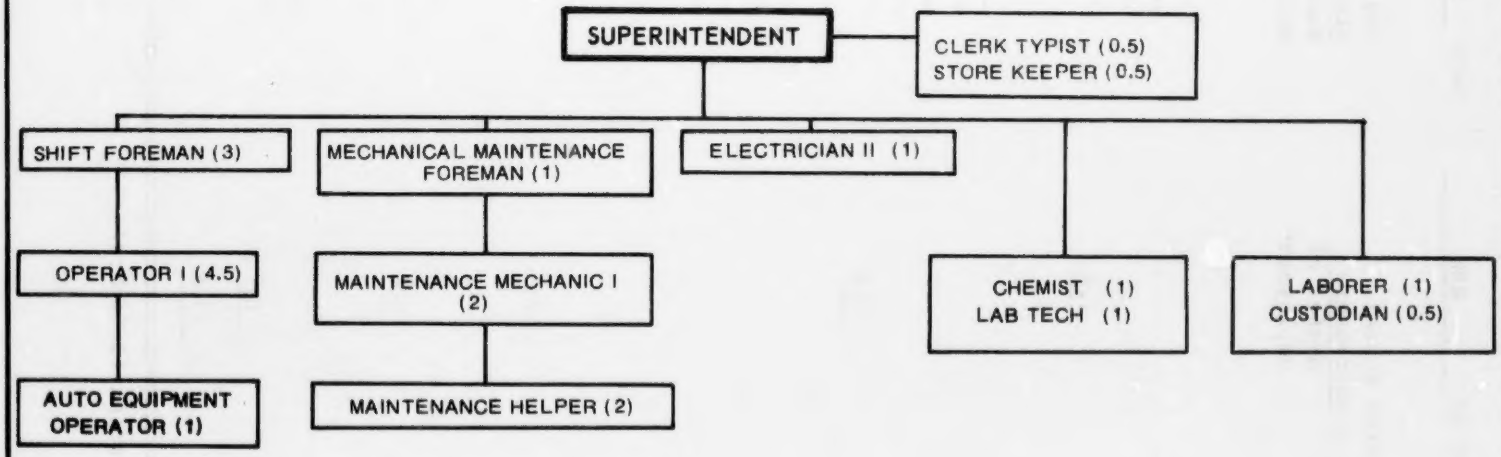
SUPERINTENDENT
CLERK TYPIST (0.5)
STORE KEEPER (0.5)
SHIFT FOREMAN (3)
MECHANICAL MAINTENANCE FOREMAN (1)
ELECTRICIAN II (1)
OPERATOR I (4.5)
MAINTENANCE MECHANIC I (2)
CHEMIST (1)
LAB TECH (1)
LABORER (1)
CUSTODIAN (0.5)
AUTO EQUIPMENT OPERATOR (1)
MAINTENANCE HELPER (2)

Figure B-6. Example No. 6 - organization chart.